DEPARTMENT OF THE ARMY
TECHNICAL MANUAL

TM 11-2400

DEPARTMENT OF THE AIR
FORCE TECHNICAL ORDER

TO 16-40 ML185-5

GENERATORS
ML-185-A, ML-185-B
AND ML-185-C

DEPARTMENTS OF THE ARMY AND THE AIR FORCE
JUNE 1951

AGO 4198B—June

DEPARTMENT OF THE ARMY TECHNICAL MANUAL
DEPARTMENT OF THE AIR FORCE TECHNICAL ORDER
GENERATORS ML–185–A, ML–185–B, ML–185–C, AND HYDROGEN GENERATOR ML–490/GM

TM 11–2400
TO 31M1–2ML185–1
CHANGES No. 2.

DEPARTMENTS OF THE ARMY
AND THE AIR FORCE
WASHINGTON 25, D. C., *16 April 1957*

TM 11–2400/TO 31M1–2ML185–1, 4 June 1951, is changed as follows:

Add the following Warning Notice on the inside front cover:

WARNING

EXPLOSIVE GAS

is used in the operation
of this equipment.

Excessive heat or pressure, electrical sparks, or fire can cause an explosion. If an explosion appears imminent, MOVE OUT OF THE AREA FAST.

EXPLOSION MAY OCCUR IF:

a. The pressure increases at a rate of more than 100 pounds per square inch per minute after 1,500 pounds per square inch has been attained.

b. The pressure is over 2,800 pounds per square inch.

Page 1, paragraph 1*c.*

Line 4. After ML–185–C add: and Hydrogen Generator ML–490/GM.

Lines 6 and 7. Delete: either the ferrosilicon process or.

Pages 2 and 3, paragraph 3.

Line 6. Delete: either the ferrosilicon process (par. 17) or.

Line 8. Delete: In the ferrosilicon process, each unit charge (par. 17*e, f,* and *i*) yields approximately 85 to 90 cubic feet (STP)[1] of hydrogen gas in 2 hours; in the aluminum process.

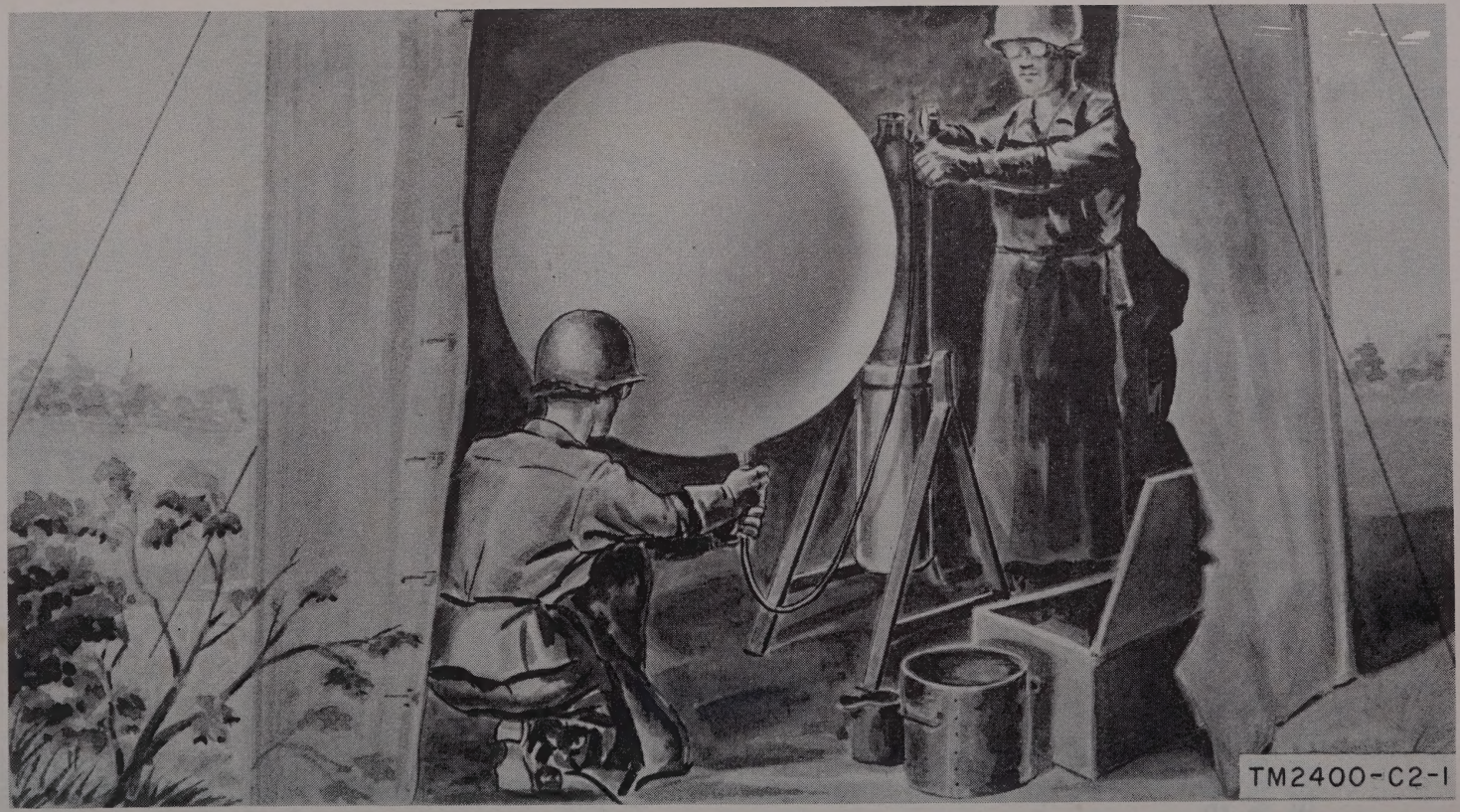

Figure 1 (Superseded) *Generator ML–185–(*) in use.*

Line 11. Change "each" to read **Each.**

Page 8, paragraph 5*a*(2). Delete the second and third sentences and substitute the following: Modified buckets (par. 1*c*) supplied with Generators ML–185–A and ML–185–B have angle-markers (internal projections) which indicate the level to which the bucket must be filled to measure 4 gallons of water. Markers placed 1½ inches below the 4-gallon markers indicate the level at which the bucket contains 3 gallons.

Page 8. Delete paragraph 6 and substitute the following:

6. Chemicals

Note. Chemicals are not supplied with the equipment. One Caustic Soda Charge ML–388/UM (Signal Corps stock No. 7A476–388), one Aluminum Charge ML–389/UM (Signal Corps stock No. 7A43–389), and 3 gallons of water, either fresh or sea, are required for one generation.

a. Caustic Soda Charge ML–388/UM (fig. 7) consists of two 1-pound sticks, 1⅝ inches in diameter by 7½ inches long, of sodium hydroxide (caustic soda), sealed in transparent plastic material.

b. Aluminum Charge ML–389/UM (fig. 7) consists of 6¼ pounds of aluminum chips packaged in a fiberboard box.

Page 11, paragraph 8. In the Hydrogen Yield, Maximum Pressure, Chemical Charge, and Water listings, delete all instructions on the ferrosilicon process.

Page 13, paragraph 10.

b. (Superseded) *Storage Room.* Store the chemicals in a room separate from the generator room. Store the aluminum and caustic soda charges apart from each other to prevent mixing if the containers are accidentally broken. Store the chemicals in separate buildings, or in a storage room constructed to enable storage of each chemical in a separate area.

Warning: The chemicals must be kept dry at all times. Remove and destroy any sodium hydroxide or caustic soda containers that show signs of rusting or other evidence of decay.

Page 20. Delete paragraph 17.

Page 21. Delete figure 10.

Page 24. Delete paragraph 18.

Page 27, paragraph 20. Delete subparagraph *a,* including the note.

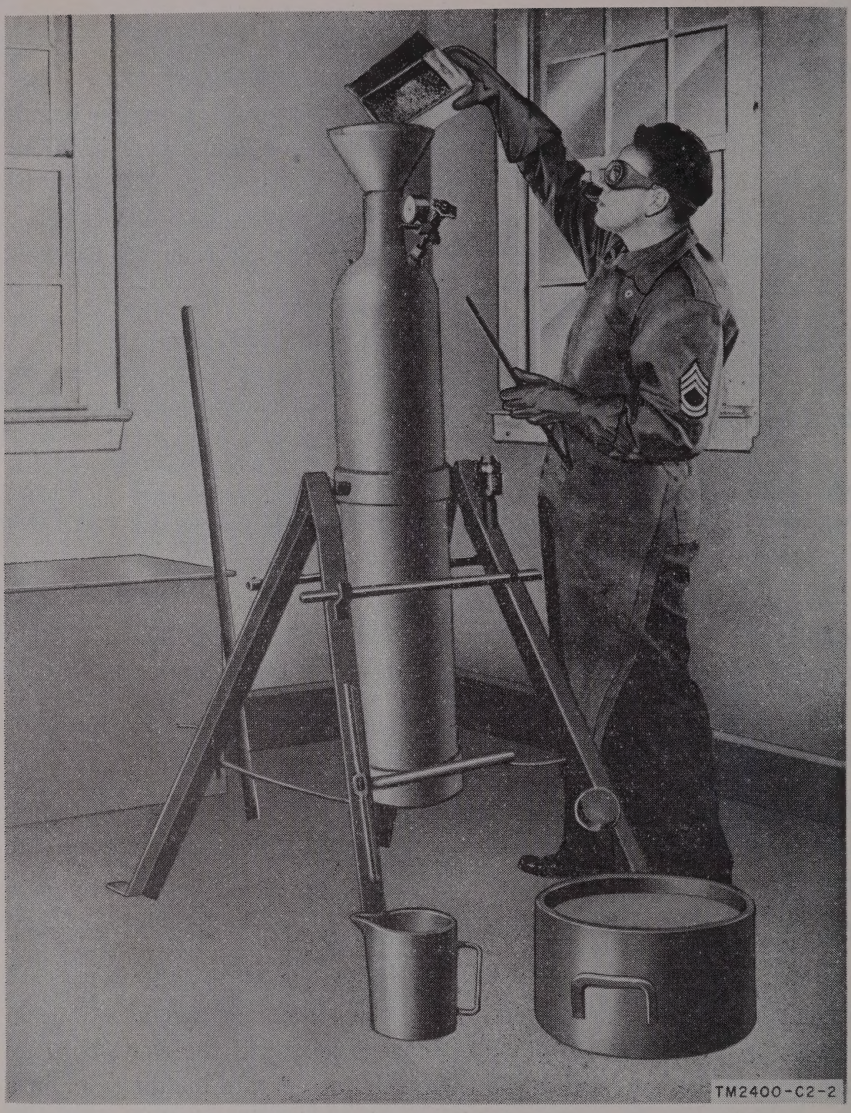

Figure 12 (Superseded) *Charging Generator ML–185–(*) with Aluminum Charge ML–389/UM.*

Page 31, paragraph 23.

Line 1. Change "paragraphs 17 through 22" to read "paragraphs **19** through 22."

Delete subparagraph *b*(1), including the caution.

Page 33, paragraph 24, line 1. Change "paragraphs 17 through 22" to read "paragraphs **19** through 22."

Page 42, paragraph 40. Delete subparagraph *a.*

[AG 679 (26 Mar 57)]

By Order of the Secretaries of the Army and the Air Force:

MAXWELL D. TAYLOR,
General, United States Army,
Chief of Staff.

Official:

HERBERT M. JONES,
Major General, United States Army,
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N. F. TWINING,
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Div	11–16
Ft & Cp	11–57
Sp Wpn Comd	11–127
Army Cml Cen	11–128
Gen & Br Svc Sch	11–500
Gen Depots	11–557
Sig Sec, Gen Depots	11–587
Sig Depots	11–592
WRAMC	11–597

NG: State AG; units—same as Active Army.

USAR: None.

For explanation of abbreviations used, see SR 320–50–1.

☆ U. S. GOVERNMENT PRINTING OFFICE: 1957—400630

DEPARTMENT OF THE ARMY TECHNICAL MANUAL
DEPARTMENT OF THE AIR FORCE TECHNICAL ORDER

GENERATORS ML-185-A, ML-185-B AND ML-185-C, AND HYDROGEN GENERATOR ML 490/GM

C 1, TM 11-2400
TO 16-40 ML185-5

DEPARTMENTS OF THE ARMY AND THE AIR FORCE
WASHINGTON 25, D. C., *9 June 1954*

TM 11-2400/TO 16-40 ML185-5, 4 June 1951, is changed as follows:

The title of the manual is changed to read:

GENERATORS ML-185-A, ML-185-B, ML-185-C AND HYDROGEN GENERATOR ML-490/GM

SAFETY NOTICE

The use of * * * at all times:

* * * * * * *

11. Beware of working pressures in excess of 2,800 pounds per square inch; NICKEL SAFETY DISKS BLOW AT 3,000 POUNDS PER SQUARE INCH, **INCONEL DISKS BLOW AT 4,000 POUNDS PER SQUARE INCH.** At pressures of 2,800 or more pounds per square inch, move away from the generator—MOVE FAST.

CHAPTER 1

INTRODUCTION

Note. (Added) Hydrogen Generator ML-490/GM is similar to Generator ML-185-C covered in the basic manual. All information in TM 11-2400 covering the ML-185-C applies equally to the ML-490/GM unless otherwise specified herein.

4. Major Components

* * * * * * *

b. Cylinder Safety Device. The cylinder safety * * * within the cylinder. **On Generators ML-185-A, ML-185-B and ML-185-C (modified) and on the ML-490/GM, the cap is sealed with a fiber washer and an inconel (nickel-chromium-iron alloy) diaphragm mounted in a brass adapter. The inconel disks rupture at 4,000 psi.** The device screws onto an adapter in the cylinder wall. The cylinder safety device is identical to and interchangeable with the valve safety device (*c*(4) below).

5. Accessory Equipment, Tools, and Spare Parts

Tools, operating accessories, * * * in paragraph 7.

a. Charging Accessories.

* * * * * * *

(2) *Buckets.* A large, water-measuring * * * (ferrosilicon process, par. 17*f*). Modified buckets (par. **1***c*) **and the bucket supplied with the ML–490/GM** have markers placed 1½ inches below the 4-gallon markers to indicate the level at which the bucket contains 3 gallons (aluminum process, par. 19*f*). The bucket supplied with Generator ML–185–C has only markers that indicate the level at which the bucket contains 3 gallons. **The ML–490/GM is supplied with a large brass cleaning rod equipped with a copper chisel-pointed tip.**

* * * * * * *

7. List of Components

Generator ML–185–(*) consists * * * of spare parts.

* * * * * * *

Operating Accessories

* * * * * * *

1 scoop

* * * * * * *

Nickel safety disks **or inconel safety disks (ML–490/GM only) 1 large brass cleaning rod (ML–490/GM only)**

Running Spare Parts [b]

* * * * * * *

1 rubberized apron

* * * * * * *

Nickel safety disks **or inconel safety disks (ML–490/GM only)**

8. Technical Characteristics

Cylinder

* * * * * * *

Safety device: Right-hand threaded * * * valve safety device.) **Generators ML–185–A, ML–185–B, and ML–185–C (modified) and the ML–490/GM have a right hand threaded screw cap containing an inconel safety disk mounted in a brass adapter, with a bursting strength of 3,900 to 4,000 psi.**

Outlet Value Assembly.

* * * * * * *

Safety device: Right-hand threaded * * * cylinder safety device.) **Generators ML–185–A, ML–185–B, and ML–185–C (modified) and the ML–490/GM have a right hand threaded screw cap**

containing an inconel safety disk mounted in a brass adapter, with a bursting strength of 3,900 to 4,000 psi.

* * * * * * *

9. Packaging Data

Hydrogen Generator ML–185–(*) * * * and the chest. **The chest for the ML–490/GM is 76¼ inches long (uncrated) instead of 61¼ inches.**

* * * * * * *

9.1. Difference in Models

(Added)

Hydrogen Generator ML–490/GM is furnished with a 12-inch adjustable wrench (box type) with a 22½° head, replacing the open-end wrench; a brass cleaning rod, replacing one of the large hardwood cleaning sticks; a longer chest to accommodate the large brass cleaning rod and to permit rearrangement of the accessories; and a large bucket with markers to indicate 3 and 4 gallon levels. The ML–490/GM is provided also with inconel safety disks. Otherwise the ML–490/GM is similar to the ML–185–C.

APPENDIX II

IDENTIFICATION TABLE OF PARTS

Rescinded

[AG 679 (21 May 54)]

By order of the Secretaries of the Army and the Air Force:

M. B. RIDGWAY,
General, United States Army,
Chief of Staff.

Official:
JOHN A. KLEIN,
Major General, United States Army,
The Adjutant General.

N. F. TWINING,
Chief of Staff, United States Air Force.

Official:
K. E. THIEBAUD,
Colonel, United States Air Force,
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Tec Svc Bd (1)	SigC Depots (20)
AFF (5)	POE (2)
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Army AA Comd (2)	SigC Fld Maint Shops (3)
OS Maj Comd (5)	SigC Lab (5)
OS Base Comd (5)	Mil Dist (1)
Log Comd (5)	Units org under fol T/O & E:
MDW (2)	11–127, Sig Rep Co (2)
Armies (5)	11–128A, Sig Depot Co (2)
Corps (2)	11–500A (AA–AE), Sig Admin Team (2)
Tng Div (2)	11–587, Sig Base Maint Co (2)
Ft & Cp (2)	11–592, Hq & Hq Co, Sig Base Depot (2)
Gen & Br Svc Sch (5)	11–597, Sig Base Depot Co (2)
SigC Sch (25)	
Gen Depots (2)	

NG: Same as Active Army except allowance is one copy for each unit.
USAR: None.
Unless otherwise noted, distribution applies to ConUS and overseas.
For explanation of abbreviations used, see SR 320–50–1.

U. S. GOVERNMENT PRINTING OFFICE: 1954

DEPARTMENT OF THE ARMY TECHNICAL MANUAL
TM 11–2400

DEPARTMENT OF THE AIR FORCE TECHNICAL ORDER
TO 16–40 ML 185–5

This manual supersedes TM 11–2400, 31 May 1945, including C1, 22 July 1946

GENERATORS ML-185-A, ML-185-B AND ML-185-C

United States Government Printing Office
Washington: 1951

AGO 4198B

DEPARTMENT OF THE ARMY
WASHINGTON 25, D. C., *4 June, 1951*

TM 11–2400/TO 16–40ML 185–5 is published for the information and guidance of all concerned.

[AG 679 (27 Apr 51)]

BY ORDER OF THE SECRETARIES OF THE ARMY AND THE AIR FORCE:

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Wm. E. BERGIN
Major General, USA
Acting The Adjutant General

J. LAWTON COLLINS
Chief of Staff, United States Army

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Air Adjutant General

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Chief of Staff, United States Air Force

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For explanation of distribution formula, see SR 310–90–1.

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SAFETY NOTICE

The use of Generator ML–185–(*) involves dangerously high gas pressures and explosive mixtures of air and hydrogen. The same hazards exist where hydrogen is stored, and when hydrogen is being taken from or transferred to a storage cylinder. Observe the following precautions at all times:

1. Display conspicuous warning signs wherever hydrogen is generated, used, or stored.
2. To prevent the accumulation of hydrogen and to permit its escape, provide permanently louvered ventilators near the floor and ceiling of any building where hydrogen is generated, used, or stored.
3. Remove all sources of flame or sparks.
4. Never smoke in or near a building where hydrogen is generated, used, or stored.
5. Do not wear shoes with nails that may strike sparks.
6. Do not drop iron or steel tools on a concrete floor nor strike them against iron or steel.
7. Do not wear fur or heavy wool clothing.
8. Ground the generator (par. 12*b*(2)) and operating personnel (par. 12*b*(5)); ground balloon cocks and nozzles while they are in use (par. 12*b*(4)); ground storage cylinders while they are in use (par. 12*b*(3)).
9. Wear safety goggles, rubber apron, and rubber gloves when handling sodium hydroxide or caustic residue.
10. Do not use the generator in the sun; do not permit storage cylinders to be heated by the sun. Excessive pressures which will rupture the safety disks may be developed.
11. Beware of working pressures in excess of 2,800 pounds per square inch; SAFETY DISKS BLOW AT 3,000 POUNDS PER SQUARE INCH. At pressures of 2,800 or more pounds per square inch, move away from the generator—MOVE FAST.

FIRST AID NOTICE

Treat caustic burns immediately. Detailed first aid instructions for the emergency treatment of caustic burns on the skin and in the eyes are given in paragraph 16 of this manual.

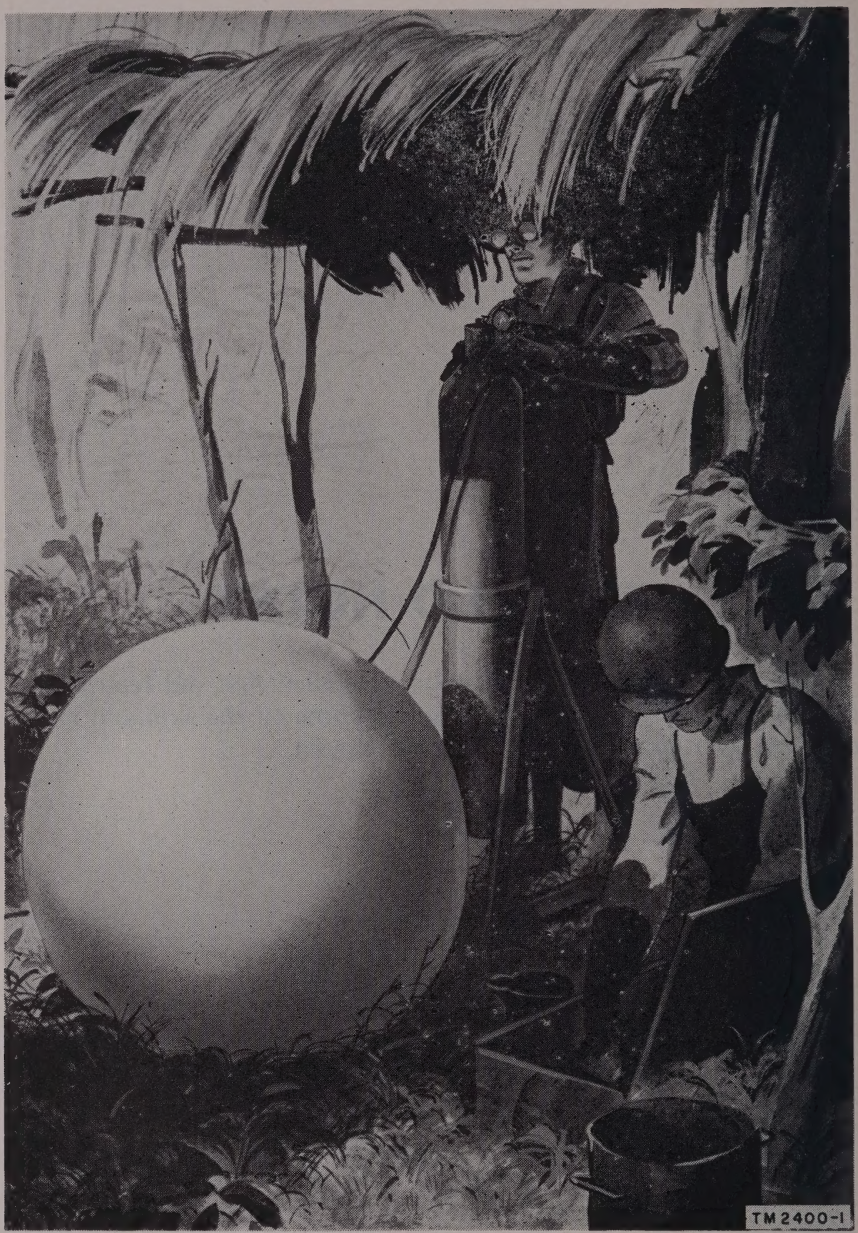

Figure 1. Generator ML–185–(*) in use.

CHAPTER 1

INTRODUCTION

Section I. GENERAL

1. Scope

a. These instructions are published for the information and guidance of the personnel to whom this equipment is issued. They contain information on the assembly, operation, maintenance, and repair of the equipment, and a discussion of the theory of operation. They apply only to Generators ML–185–A, ML–185–B, and ML–185–C.

b. Appendix I contains a list of current references, including supply catalogs, technical manuals, and other available publications applicable to the equipment. Appendix II contains an identification table of parts.

c. Throughout this manual, basic nomenclature followed by (*) is used to indicate all models of an item of equipment; for example, Generator ML–185–(*) represents Generators ML–185–A, ML–185–B, and ML–185–C. Generators ML–185–A and ML–185–B which have been modified according to the instructions contained in MWO SIG 11–2400–1, March 1945, are essentially the equivalent of Generator ML–185–C which is designed to generate hydrogen gas by either the ferrosilicon process or the aluminum process. All information applies equally to all three models unless otherwise stated in this manual.

Caution: Generators ML–185–A and ML–185–B that have not been modified in accordance with MWO SIG 11–2400–1 *cannot* be used for generating hydrogen gas by the aluminum process.

2. Forms and Records

The following forms will be used for reporting unsatisfactory conditions of Army equipment and in performing preventive maintenance.

a. DD Form 6, Report of Damaged or Improper Shipment, will be filled out and forwarded as prescribed in SR 745–45–5 (Reports Control Symbol CSGLD–66 (Army), S and A–70–6 (Navy), and AF–MC–42 (Air Force)).

b. DA AGO Form 468, Unsatisfactory Equipment Report, will be filled out and forwarded to the Office of the Chief Signal Officer, as prescribed in SR 700–45–5 (Reports Control Symbol CSGLD–247).

c. AF Form 54, Unsatisfactory Report, will be filled out and forwarded to Commanding General, Air Matériel Command, Wright-Patterson Air Force Base, Dayton, Ohio, as prescribed in SR 700–45–5 and AFR 65–26.

d. DA AGO Form 419, Preventive Maintenance Checklist for Signal Corps Equipment, will be prepared in accordance with instructions on the back of the form.

e. Use other forms and records as authorized.

Section II. DESCRIPTION AND DATA

3. General

Generator ML–185–(*) is complete equipment for generating hydrogen gas to inflate meteorological balloons. It consists of a steel cylinder body with plug, regulating and discharge valve, outlet hose coupling, pressure gage and safety devices, support assembly, and all the tools and accessories (except the chemicals, which are not furnished with the equipment) required to generate hydrogen gas by either the

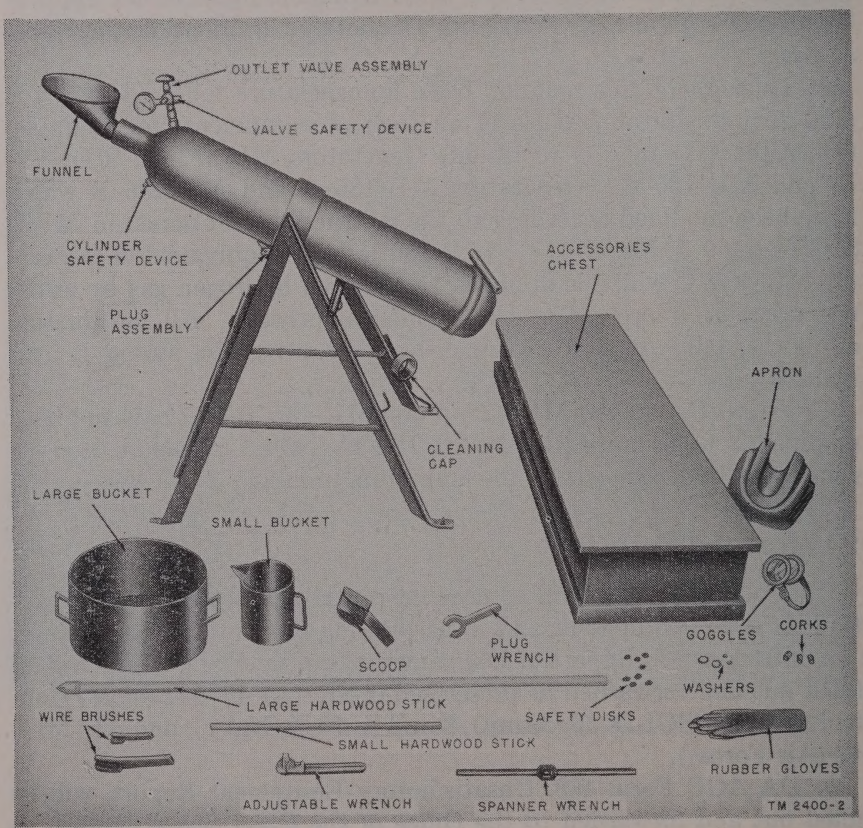

Figure 2. Generator ML–185–(*) assembled, with accessories.

ferrosilicon process (par. 17) or the aluminum process (par. 19), and to maintain the equipment in good order. In the ferrosilicon process, each unit charge (par. 17*e*, *f*, and *i*) yields approximately 85 to 90 cubic feet (STP)[1] of hydrogen gas in 2 hours; in the aluminum process, each unit charge (par. 19*e*, *f*, and *i*) yields approximately 120 cubic feet (STP) of hydrogen gas in 2¼ hours.

4. Major Components

a. CYLINDER ASSEMBLY. The cylinder assembly consists of a cylinder body and a large plug assembly.

(1) *Cylinder body.* The seamless steel cylinder body is 56 inches long and has an outside diameter of 9$^{9}/_{16}$ inches; it weighs approximately 275 pounds. The cylinder has an internal volume of approximately 2,600 cubic inches and a liquid capacity of 11⅓ gallons. The body of the cylinder will withstand an internal pressure of 5,000 pounds per square inch. A cylinder safety device adapter and an outlet valve adapter are located opposite each other near the top of the cylinder body. Brass caps are provided to protect the threads of these adapters when the outlet valve and the cylinder safety device are not installed. Trunnions, mounted on a shrunk-fit band which encircles the cylinder approximately 30 inches from the bottom, provide a means of mounting the generator on the support and form an axis upon which the cylinder can be turned. A metal bar, mounted on a shrunk-fit band which encircles the cylinder approximately 4 inches from the bottom, serves as a handle and is used to facilitate swinging and turning the generator. The neck of the cylinder has an opening, 2¾ inches in diameter at the top and 1$^{13}/_{16}$ inches in diameter at the throat, through which the generator is charged. The upper part of the opening has a right-hand internal screw thread to accommodate the plug assembly. Two pins project from the neck and serve to secure the offset funnel (par. 5*a*) during the charging operation and to secure the cleaning cap during the cleaning operation.

(2) *Plug assembly* (fig. 3). The plug assembly closes the opening in the neck of the cylinder after it has been charged and provides a vaporproof seal while the generator is in use. The assembly consists of a right-hand threaded plug which screws into the threaded opening in the cylinder neck, and of a rubber-faced seal, controlled by a center screw, which passes through the body of the plug and forces the seal tightly into the smaller, lower neck opening.

[1] Standard conditions of temperature and pressure.

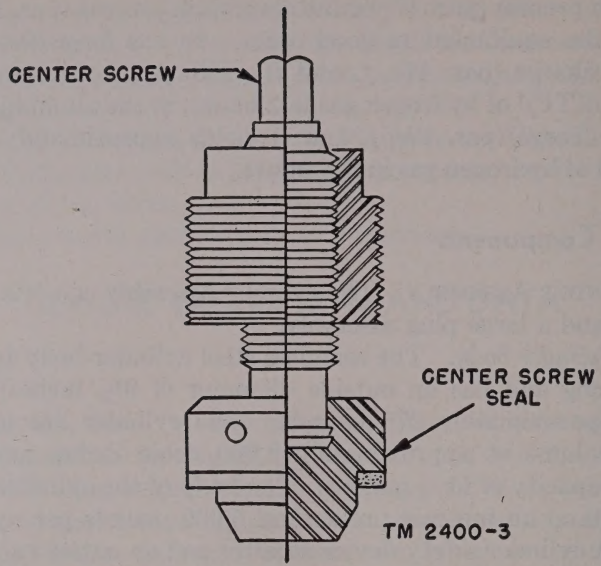

Figure 3. Large plug assembly, cutaway view.

b. CYLINDER SAFETY DEVICE. The cylinder safety device consists of a metal screw cap with a sleeve which can be rotated; there is a

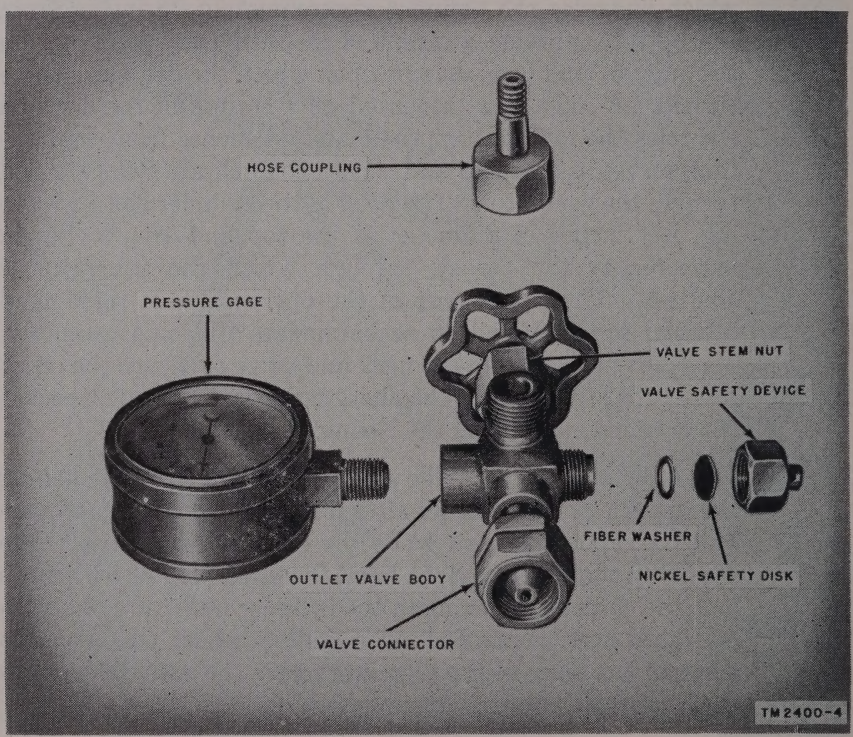

Figure 4. Outlet valve assembly, components.

small, radial aperture in the sleeve. The cap is closed with a thin, replaceable, nickel disk and sealed, when it is screwed in place, with a fiber washer. The nickel disk ruptures at pressures exceeding 3,000 pounds per square inch and permits gas to escape through the aperture in the sleeve in order to relieve excessive pressure within the cylinder. The device screws onto an adapter in the cylinder wall. The cylinder safety device is identical to and interchangeable with the valve safety device (*c*(4) below).

c. OUTLET VALVE ASSEMBLY (fig. 4). The outlet valve assembly consists of a regulating and discharge valve contained in a bronze body and controlled by a handwheel, and of a pressure gage, a hose coupling, and a valve safety device. A left-hand threaded coupling attaches the assembly to the outlet valve adapter in the side of the cylinder body (*a*(1) above).

(1) *Regulating and discharge valve* (fig. 5). This is a corrosion-resistant, high-pressure, wheel-controlled needle valve contained in a bronze body. It has an outlet connection and provisions for attaching an inlet coupling, a pressure gage, and a valve safety device. The valve is used to regulate the rate of discharge of hydrogen from the cylinder.

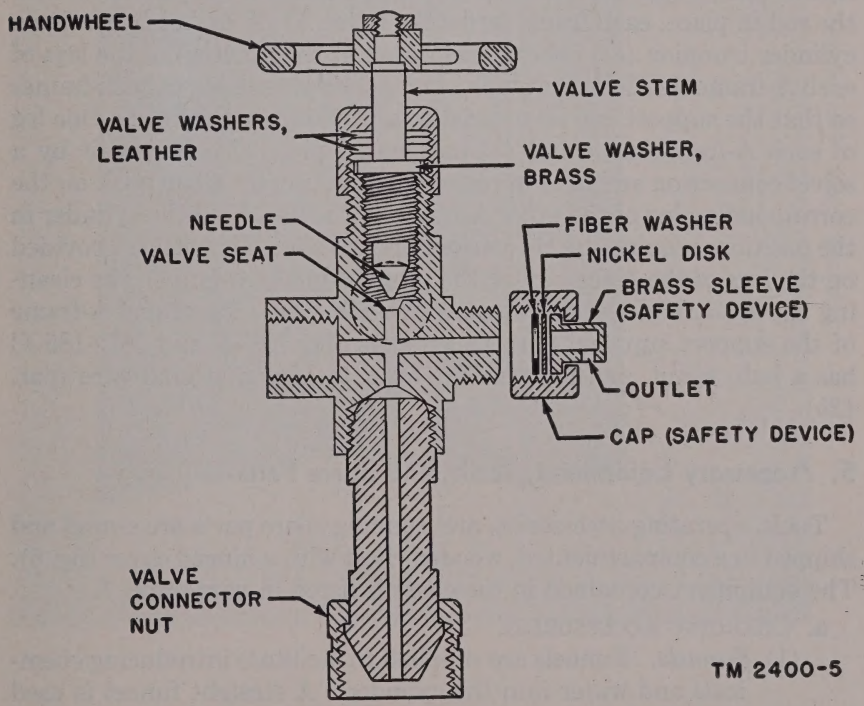

Figure 5. Regulating and discharge valve with safety device, sectional view.

(2) *Pressure gage* (fig. 4). The pressure gage screws into the body of the outlet valve assembly. The black scale on the dial of the gage is graduated in pounds per square inch over a range from 0 to 3,000 pounds per square inch (the red scale is not applicable to Generator ML–185–(*)). The gage indicates the pressure of the gas within the cylinder.

(3) *Outlet hose coupling* (fig. 4). The outlet hose coupling provides a means of attaching Hose ML–81 to the outlet connection of the valve body. One end of the coupling is provided with a left-hand threaded coupling nut which secures it to the valve assembly; the other end of the coupling is a serrated sleeve for the attachment of the hose.

(4) *Valve safety device* (figs. 4 and 5). The valve safety device is identical to and interchangeable with the cylinder safety device (*b* above). The device screws onto an adapter on the valve body; it is intended to relieve excessive pressure in the valve assembly.

d. SUPPORT ASSEMBLY (fig. 2). The support assembly holds the generator while it is in use and has provisions for securing the cylinder in the various required positions during the charging and cleaning operations. The support consists of two folding A-frames; the two legs of each frame are held apart by a rod secured by eye hooks; with the rod in place, each frame forms the letter A. A socket to receive a cylinder trunnion (*a*(1) above) is located at the junction of the legs of each A-frame. A hole is provided in the foot of each leg of both frames so that the support can be secured to a platform or the floor. One leg of each A-frame has a bar (¾-inch metal pipe) attached to it by a seivel connection and held in place, when in use, by a bar hook on the corresponding leg of the other A-frame. The bars hold the cylinder in the positions required by the various operations. Holders are provided on the legs of the A-frames for the plug assembly, a funnel, the cleaning cap assembly, and the spanner wrench. One leg of one A-frame of the support supplied with Generators ML–185–B and ML–185–C has a bolt, a nut, and flat washers for attaching a ground wire (par. 12*b*).

5. Accessory Equipment, Tools, and Spare Parts

Tools, operating accessories, and running spare parts are stored and shipped in a compartmented, wooden chest with a hinged cover (fig. 6). The equipment contained in the chest is listed in paragraph 7.

a. CHARGING ACCESSORIES.

(1) *Funnels.* Funnels are supplied to facilitate introducing chemicals and water into the cylinder. A straight funnel is used when the generator is in a upright position (fig. 11); an offset funnel is used when the generator is tilted (fig. 10).

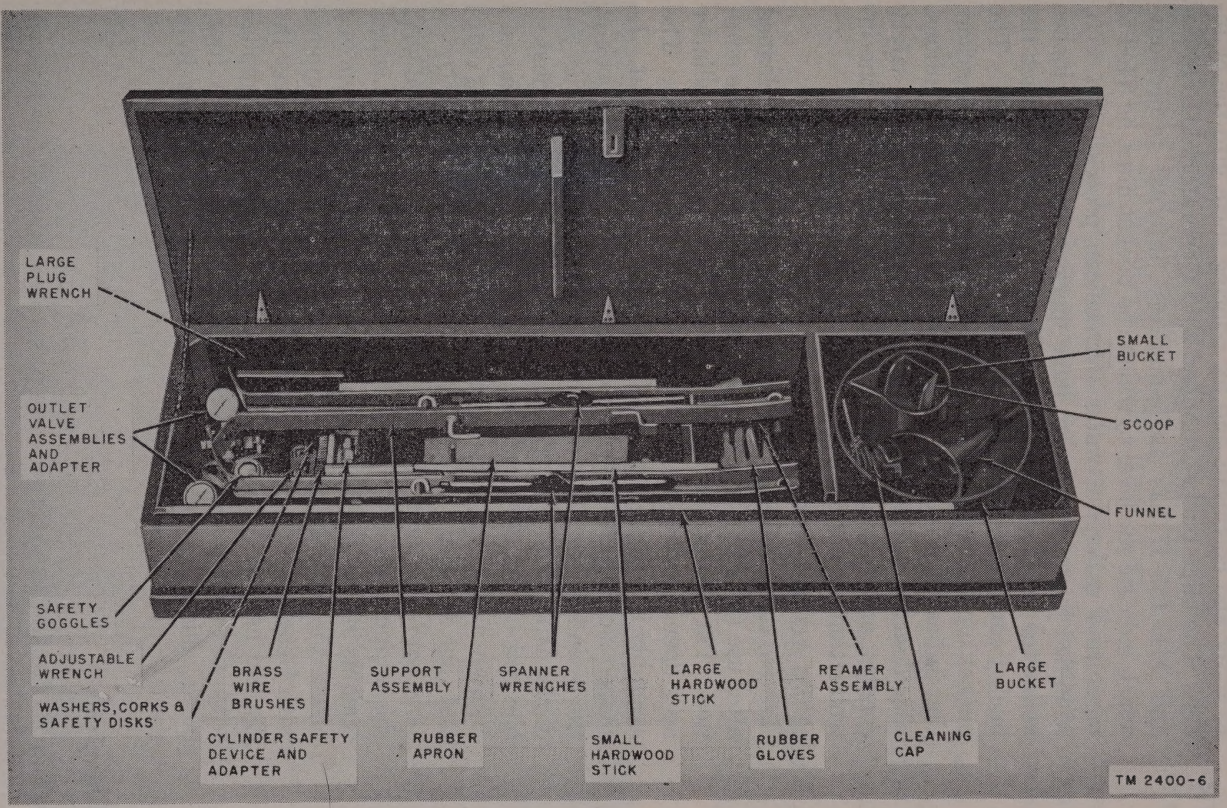

Figure 6. Chest open, showing accessories and spare parts.

(2) *Buckets.* A large, water-measuring bucket and a small bucket, used as a dipper, are furnished with the equipment to provide a convenient means of measuring the required amount of water and chemicals and for pouring them into the cylinder. The large bucket supplied with Generators ML–185–A and ML–185–B has angle-markers (internal projections) which indicate the level to which the bucket must be filled to measure 4 gallons of water (ferrosilicon process, par. 17*f*). Modified buckets (par. 1*c*) have markers placed 1½ inches below the 4-gallon markers to indicate the level at which the bucket contains 3 gallons (aluminum process, par. 19*f*). The bucket supplied with Generator ML–185–C has only markers that indicate the level at which the bucket contains 3 gallons.

(3) *Miscellaneous accessories.* Rubber gloves, an apron, safety goggles, and a small hardwood stick for facilitating the introduction of chemicals into the cylinder are supplied.

b. Cleaning Accessories.

(1) *Cleaning cap assembly.* When the generator is being cleaned after use (par. 22), the cylinder must be inverted to be emptied. The cleaning cap assembly is used to close the cylinder neck opening while the cylinder is turned over (fig. 13). The assembly is a metal cap which contains a rubber gasket. L-shaped slots in the side wall engage the pins on the neck of the cylinder (par. 4*a*); a short metal bar welded to the top of the cap provides a handle, and a metal chain attached to one end of the bar provides a means of removing the cap without danger to personnel when the cylinder is being emptied (par. 22*f* and *i*).

(2) *Large hardwood stick.* The long, hardwood pole furnished with the equipment is used to break up the solidified residue which remains in the cylinder after use and which must be removed before the generator can be used again. The pole supplied with Generator ML–185–A has a brass ring slipped over the tip and held in place by a pin; the improved pole supplied with Generators ML–185–B and ML–185–C has a four-faced, chisel-pointed, bronze tip secured to the pole by a rivet.

6. Chemicals

Sodium hydroxide (caustic soda) in flake form (Signal Corps stock No. 7A1675) and ferrosilicon (Signal Corps stock No. 7A880) are used with Generator ML–185–(*) to produce hydrogen gas by the ferrosilicon process. Caustic Soda Charge ML–388/UM (Signal Corps stock No. 7A476–388) and Aluminum Charge ML–389/UM (Signal Corps stock No. 7A43–389) are used with Generator ML–185–(*) to

produce hydrogen by the aluminum process. These chemicals are not components of the equipment; use Table of Allowances of Expendable Supplies (T/AES) as a basis for requisitioning chemical supplies.

a. FERROSILICON PROCESS. For one generation, Generator ML–185–(*) requires 5 pounds of sodium hydroxide, 4½ pounds of ferrosilicon, and 4 gallons of water, either fresh or sea.

(1) Sodium hydroxide (98%) is provided in flake form (known commercially as *technical flakes*). It may be supplied in bulk, but is usually supplied in cans containing 5 pounds, packed for export shipment, 24 cans to a case.

(2) Ferrosilicon (90% silicon; grain size, ¼-inch by down) is usually supplied in bags containing 4½ pounds. If it is supplied in air-tight, metal containers, a small hole should be punched in each container to release any gas formed by the decomposition of impurities.

Caution: Sodium hydroxide and ferrosilicon react violently in the presence of moisture and release hydrogen gas. Never store them so there is any possibility of their coming in contact with one another.

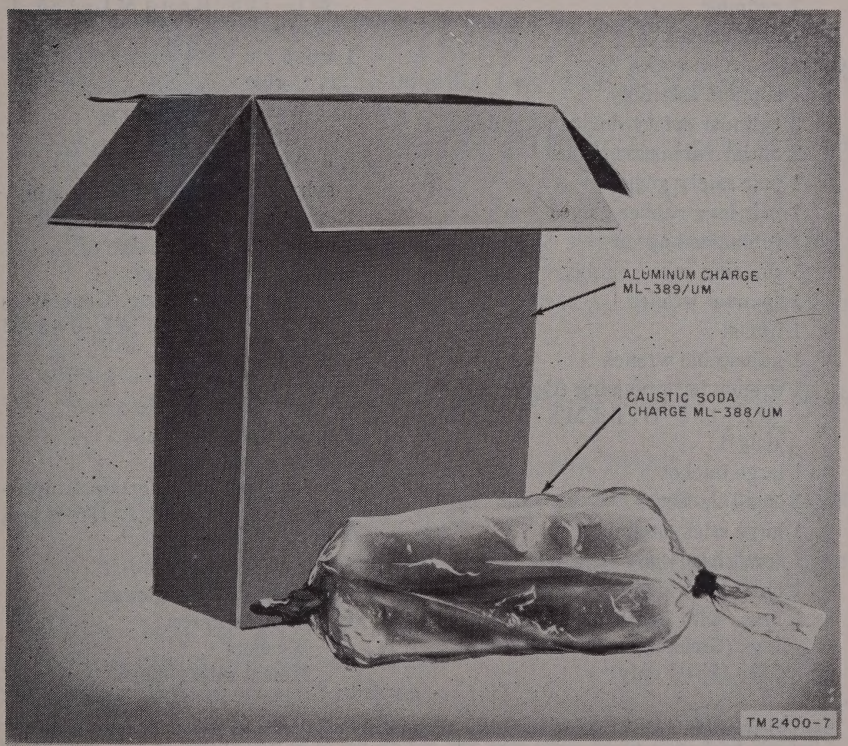

Figure 7. Packaged chemicals for aluminum process.

b. ALUMINUM PROCESS. For one generation, Generator ML–185–(*) requires one Caustic Soda Charge ML–388/UM, one Aluminum Charge ML–389/UM, and 3 gallons of water, either fresh or sea.

(1) Caustic Soda Charge ML–388/UM (fig. 7) consists of two 1-pound sticks, 1⅝ inches in diameter by 7½ inches long, of sodium hydroxide (caustic soda), sealed in a transparent plastic material.

(2) Aluminum Charge ML–389/UM (fig. 7) consists of 6¼ pounds of aluminum chips packaged in a fiberboard box.

7. List of Components

Generator ML–185–(*) consists of a cylinder assembly, the tools and accessories required to operate the equipment, and a group of running spare parts. The operating accessories and the running spare parts are contained in a wooden chest designed to hold them conveniently for storage or shipment. A complete list of the components of Generator ML–185–(*) is given below. This list is for general information only. See appropriate publications for information pertaining to requisitioning of spare parts.

Cylinder Assembly
- 1 cylinder
- 1 plug assembly

Operating Accessories
- 1 support assembly
- 2 cylinder safety device assemblies
- 2 outlet valve assemblies
- 1 pair safety goggles
- 1 pair long rubber gloves
- 1 rubberized apron
- 1 cleaning cap assembly
- 1 spanner wrench
- 1 funnel
- 1 adjustable wrench
- 1 wrench for large plug (Generators ML–185–B and ML–185–C only)[a]
- 1 large bucket
- 1 small bucket
- 1 large stick assembly
- 1 small hardwood stick
- 1 brass wire brush
- 1 brass wire brush for small openings (Generators ML–185–B and ML–185–C only)[a]
- 1 reamer assembly (Generators ML–185–B and ML–185–C only)[a]
- 1 scoop
- Corks
- Washers
- Nickel safety disks

Running Spare Parts[b]
- 1 cylinder safety device assembly
- 1 cylinder safety device adapter
- 1 outlet valve assembly
- 1 outlet valve adapter
- 1 wrench for large plug (Generators ML–185–B and ML–185–C only)[a]
- 1 spanner wrench
- 1 large stick assembly
- 1 small hardwood stick
- 1 brass wire brush
- 1 brass wire brush for small openings (Generators ML–185–B and ML–185–C only)[a]
- 1 pair safety goggles
- 1 pair long rubber gloves
- 1 rubberized apron
- Washers
- Nickel safety disks

[a] If Generator ML–185–A is being used, order these items from the supply depot.
[b] Running spare parts are for initial issue only and are not to be requisitioned as a kit or group as shown in this list.

8. Technical Characteristics

Cylinder—
- Construction: Seamless steel
- Size: 9 9/16 in. OD; 56 in. long
- Internal volume: Approximately 2,600 cubic inches
- Capacity (liquid): 11 1/3 gallons
- Strength: Body will withstand internal pressure of 5,000 psi
- Safety device: Right-hand threaded screw cap containing nickel disk 19/32-in. in diameter; bursting strength 3,000 to 3,700 psi. (Interchangeable with valve safety device.)

Outlet Valve Assembly—
- Type: Needle valve, wheel controlled
- Body: Bronze
- Stem: Stainless steel
- Inlet coupling: Bronze; connected to valve body by ball and cone joint
- Pressure gage: Graduated in pounds per square inch, from 0 to 3,000 psi (black scale; red scale not used)
- Safety device: Right-hand threaded screw cap containing nickel disk 19/32-inch in diameter; bursting strength 3,000 to 3,500 psi. (Interchangeable with cylinder safety device.)
- Support: Two folding metal A-frames

Hydrogen Yield—
- Ferrosilicon process: 85 to 90 cubic feet (STP) in 2 hours with air temperature 70° F to 90° F
- Aluminum process: 120 cubic feet (STP) in 2 1/4 hours with air temperature 60° F to 90° F

Maximum Pressure—
- Ferrosilicon process: 1,600 to 2,100 psi when generator is hot; 1,200 to 1,500 psi when generator is cold
- Aluminum process: Approximately 2,300 psi when generator is hot

Chemical Charge—
- Ferrosilicon process: 5 lb sodium hydroxide (Signal Corps stock No. 7A1675)
  4 1/2 lb ferrosilicon (Signal Corps stock No. 7A880)
- Aluminum process: Caustic Soda Charge ML–388/UM (Signal Corps stock No. 7A476–388)
  Aluminum Charge ML–389/UM (Signal Corps stock No. 7A43–389)

Water (fresh or sea)—
- Ferrosilicon process: 4 gallons
- Aluminum process: 3 gallons

9. Packaging Data

Hydrogen Generator ML–185–(*) is packed for shipment in two crates. One crate contains the cylinder assembly, the other contains the chest with all the accessories and spare parts. A complete list of all the components is given in paragraph 7. The following table gives the dimensions and the volumes of the cylinder and the chest.

Item	Dimensions (in.)		Weight (lb)		Volume (cu ft)
	Uncrated	Crated	Uncrated	Crated	Crated
Cylinder	56 lg; 9 9/16 dia.	14 3/4 x 20 1/2 x 61 1/4.	275	340	10.6
Chest	61 1/4 x 20 3/4 x 11 1/2.	75 x 22 x 12 3/4.	225	280	12

CHAPTER 2

OPERATING INSTRUCTIONS

Section I. SERVICE UPON RECEIPT OF EQUIPMENT

10. Siting

a. GENERAL. As a safety measure, a shelter in which hydrogen is generated should be located at a distance from other buildings. A plan for a suitable shelter is given in figure 8; this is a suggested plan only and may be varied to suit local conditions. Whenever possible, construct or use a building with permanently open, louvered ventilators near the floor and ceiling to allow the escape of hydrogen in case of leakage. The shelter should have barndoor-type sliding doors (or doors that open outward) large enough to provide an exit that permits the passage of the largest inflated balloon that may be used. If practicable, there should be such doors in each of the four sides of the building so that balloons may be taken out as nearly as possible in the direction towards which the wind is blowing. Smooth or pad all door frames and all sharp corners within the building to prevent damage to balloons. Construct the walls of a caustic-resistant, nonabsorbent, and easily-scrubbed material, such as concrete or brick. Make the floor of concrete (sodium hydroxide eats away wood, but a dirt floor is satisfactory) with suitable drainage pits which connect with a *covered* cesspool; an open cesspool is very dangerous to animal life. All electric outlets and fixtures must be explosion proof and so installed and maintained that there is no possibility of arcing or short circuits. If running water is not available, a water storage tank should be installed in the generator room.

b. STORAGE ROOM. It is desirable to store the chemicals in a room separate from the generator room. Store the sodium hydroxide, ferrosilicon, and the aluminum and caustic soda charges apart from each other so that they cannot mix if the containers break. Keep the chemicals dry. *Punch a small hole in all sealed metal ferrosilicon containers.*

c. PROTECTION OF GENERATOR IN ARCTIC REGIONS.

(1) *Heated shelter.* In extremely cold areas, provide, if possible, a heated shelter for Generator ML–185–(*). The heater should keep the generator room above 40° F. Use an indirect heating system, preferably a hot air system, located in a separate building or in a portion of the generator build-

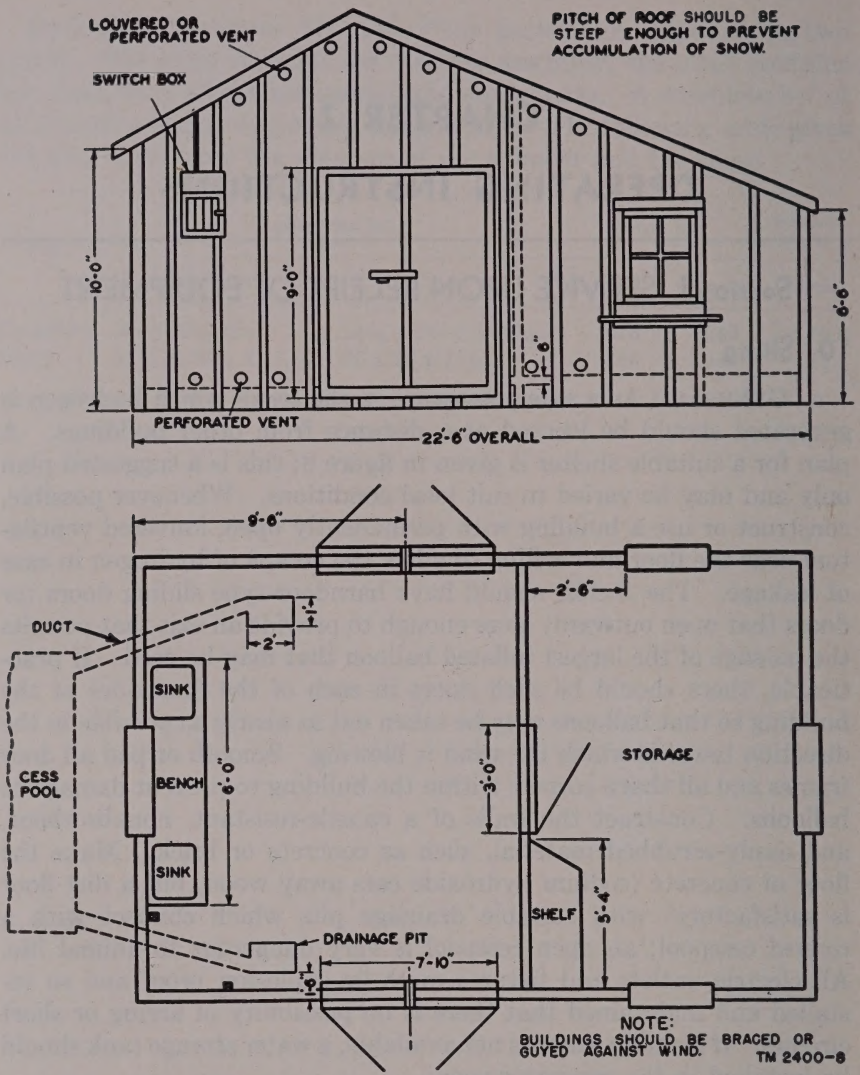

Figure 8. Plan for shelter for Generator ML–185–(*).

ing *completely separated by a fireproof partition* from the room in which hydrogen is generated. Entrance to the heater room should be made from the outside, not through the generator room. A plan for a suitable heating system is shown in figure 9.

Caution: Never use a stove or open heater to warm a shelter where hydrogen is stored or generated. All possibility of fire or explosion caused by sparks or an open flame must be eliminated. Provide ample ventilation for the immediate removal of hydrogen gas in case of leakage.

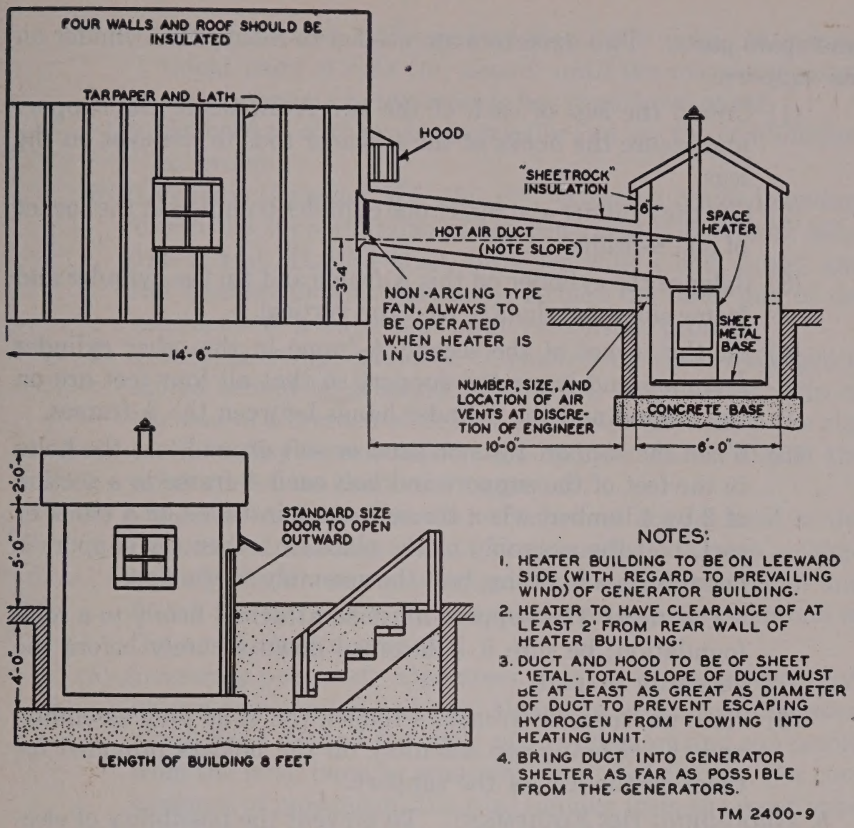
FOUR WALLS AND ROOF SHOULD BE INSULATED
TARPAPER AND LATH
HOOD
"SHEETROCK" INSULATION
6"
SPACE HEATER
HOT AIR DUCT (NOTE SLOPE)
3'-4"
NON-ARCING TYPE FAN, ALWAYS TO BE OPERATED WHEN HEATER IS IN USE.
SHEET METAL BASE
14'-6"
NUMBER, SIZE, AND LOCATION OF AIR VENTS AT DISCRETION OF ENGINEER
CONCRETE BASE
10'-0"
6'-0"
2'-0"
5'-0"
4'-0"
STANDARD SIZE DOOR TO OPEN OUTWARD
LENGTH OF BUILDING 8 FEET
NOTES:
1. HEATER BUILDING TO BE ON LEEWARD SIDE (WITH REGARD TO PREVAILING WIND) OF GENERATOR BUILDING.
2. HEATER TO HAVE CLEARANCE OF AT LEAST 2' FROM REAR WALL OF HEATER BUILDING.
3. DUCT AND HOOD TO BE OF SHEET METAL. TOTAL SLOPE OF DUCT MUST BE AT LEAST AS GREAT AS DIAMETER OF DUCT TO PREVENT ESCAPING HYDROGEN FROM FLOWING INTO HEATING UNIT.
4. BRING DUCT INTO GENERATOR SHELTER AS FAR AS POSSIBLE FROM THE GENERATORS.
TM 2400-9

Figure 9. Plan for heating system for generator shelter.

(2) *Without heated shelter.* In extremely cold areas, when it is not possible to provide a heated shelter, use Generator ML–185–(*) in a place protected from wind and snow or icy precipitation. Special instructions for the use of the generator in the Arctic are given in paragraph 23.

11. Unpacking and Checking

Generator ML–185–(*) is packed for shipment in two crates (par. 9). Carry the crates to the shelter or the location where the generator will be installed. Open the crates (use a standard nail puller) and remove the cylinder assembly and the chest. Open the chest and check the contents against the list of components (par. 7). Take care not to overlook or lose any of the accessories or small parts; leave them in, or return them to, the chest until they are needed.

12. Assembly

a. MOUNTING CYLINDER ON SUPPORT ASSEMBLY. The cylinder support assembly is stored in the chest which contains all the accessories

and spare parts. Two operators are needed to mount the cylinder on its support.

(1) Unfold the legs of each of the two A-frames of the support and secure the hooks of the spreader rods in the eyes on the legs.

(2) Lift the cylinder and insert one cylinder trunnion in the socket of one A-frame.

(3) Balance the cylinder on this A-frame and tip the cylinder and frame sideways slightly past the vertical.

(4) Fit the socket of the second A-frame in the other cylinder trunnion and lower the support so that all four feet are on the ground and the cylinder hangs between the A-frames.

(5) When the support rests on sand or soft ground, use the holes in the feet of the support and bolt each A-frame to a section of 2 by 4 lumber; when the support is installed on a truck or cart, bolt the assembly to the platform; when the support is installed in a building, bolt the assembly to the floor.

Caution: The support must be attached firmly to a solid foundation; be sure it is fastened down securely before the generator is used.

(6) Place the spanner wrench, a funnel, the large plug assembly, and the cleaning cap assembly on the holders provided for them on the legs of the support.

b. GROUNDING THE EQUIPMENT. To prevent the possibility of electrostatic discharges which might cause a fire or explosion, Generator ML–185–(*), hydrogen storage cylinders, metal cocks and nozzles used in the inflation of balloons, and the personnel handling such equipment should be grounded. Wherever possible, make ground connections to a water pipe; this is one of the best possible grounds and is often conveniently available. When no satisfactory ground is available, a ground must be established.

(1) *Establishing ground.* It is recommended that the following procedure be used to establish a ground:

(*a*) Drive two ground rods, spaced approximately 20 feet apart, into the earth to a depth of approximately 4 feet. Measure the resistance between these rods; use a slide-wire bridge, a Wheatstone bridge, an ohmmeter, or some other device suitable for measuring ground resistance.

(*b*) If the measured resistance is greater than 1,000 ohms, drive a second pair of ground rods to form two rows of rods. The distance between each rod and the next in a row should be approximately 5 feet. Connect the rods in each row electrically and measure, as before ((*a*) above), the resistance between the *rows*.

(*c*) If the resistance still is greater than 1,000 ohms, drive additional pairs of rods ((*b*) above) until the measured resistance between the two rows is less than 1,000 ohms.

(*d*) Connect all of the rods electrically and use the combination as ground.

(2) *Grounding Generator ML–185–*(*). Attach a braided conductor to the support frame of the generator (Generators ML–185–B and ML–185–C are provided with a bolt, a nut, and flat washers for this purpose). Attach the other end of the conductor to a water pipe or an established ground.

(3) *Grounding storage cylinders.* Cylinders in which hydrogen is stored should be grounded. Attach a large battery clip to one end of a braided or flexible conductor and fasten the clip to the safety device cap on the cylinder valve; attach the other end of the conductor to ground.

(4) *Grounding cocks and nozzles.* Cocks and nozzles used in the inflation of balloons should be grounded. Attach a large battery clip to one end of a braided or flexible conductor and fasten the clip to the cock or nozzle; attach the other end of the conductor to ground.

(5) *Grounding personnel.* Operators working in areas where hydrogen is generated and used should be grounded. Secure a metal band around the wrist of the operator and run a wire from the wrist band to some well-grounded object. For convenience of movement, the wire running from the wrist band may terminate in a telephone plug which readily can be inserted into or removed from a permanently grounded jack.

13. Preparing Generator ML–185–(*) for Storage or Shipment

a. Empty the generator and clean it thoroughly (par. 22).

b. Remove the outlet valve assembly; disassemble and clean it (par. 46*a*). Remove and clean the cylinder safety device.

c. Clean all threaded parts (pars. 27 and 28) and apply a light coating of grease (par. 35).

d. Screw the protective caps on the adapters and screw the large plug assembly into the neck of the cylinder.

e. Remove the cylinder from the support and repack the cylinder in its crate.

f. Pack the support and the accessories in the chest; check (par. 7) to be sure that all are present. Repack the chest in its crate.

Section II. PRELIMINARY PROCEDURES

14. Preparation of Generator ML–185–(*) for Use

a. Thoroughly inspect the equipment before attaching the outlet valve assembly to the cylinder.

(1) Remove the protective caps from the adapters in the side wall of the cylinder. Run a stiff wire through the openings to make certain they are clear.

(2) Inspect the safety devices. Be sure the washers and nickel disks are in good condition and properly in place. Replace damaged or improperly seated washers and disks (par. 44*a*).

(3) Be sure the threads of the large plug assembly and the threads on the inside of the neck of the cylinder are clean and lightly greased. Inspect the rubber gasket in the plug; replace the gasket if it is worn.

b. Assemble the outlet valve assemble by screwing the pressure gage, the valve safety device, and the hose coupling (left-hand threads) into place (fig. 4).

c. Screw the outlet valve assembly into the large adapter (left-hand thread), and screw the cylinder safety device into the small adapter on the cylinder.

d. Adjust the sleeve of each safety device so that, in the event the disk ruptures, the outlet opening will direct the discharge obliquely down and away from the operators and the cylinder.

e. Test the large plug assembly by screwing it by hand into the neck of the cylinder. The plug should screw in easily without the aid of a wrench. Remove the plug and place it on the holder provided on the support.

15. Precautions To Be Observed

The special attention of all personnel using Generator ML–185–(*) or working in areas where hydrogen is generated or stored is directed to the SAFETY NOTICE in the front of this manual. The use of Generator ML–185–(*) involves dangerously high gas pressures and explosive mixtures of air and hydrogen. Observe the following precautions at all times:

a. Display conspicuous warning signs wherever hydrogen is generated, used, or stored.

b. To prevent the accumulation of hydrogen and to permit its escape, provide permanently louvered ventilators near the floor and ceiling of any building where hydrogen is generated, used, or stored.

c. Remove all sources of flame or sparks.

d. Never smoke in or near the generator shack.

e. Do not wear shoes with nails that may strike sparks.

f. Do not drop iron tools on a concrete floor nor strike them against iron.

g. Do not wear heavy wool or fur clothing.

h. Ground the generator and operating personnel; ground balloon cocks and nozzles while they are in use; ground storage cylinders while they are in use (par. 12*b*).

i. Wear safety goggles, rubber apron, and rubber gloves when handling sodium hydroxide or caustic residue.

j. Do not use the generator in sunlight or direct rays of the sun; if the cylinder is heated by the sun, excessive pressures may be developed.

k. Beware of working pressures in excess of 2,800 pounds per square inch; SAFETY DISKS BLOW AT 3,000 POUNDS PER SQUARE INCH. At pressures of 2,800 pounds per square inch or more, move away from the generator—MOVE FAST.

16. Treatment of Caustic Burns

Sodium hydroxide (caustic soda) and caustic residue cause serious, painful, and slow-to-heal burns. Caustic burns in or about the eyes are extremely dangerous, and may cause loss of sight. An itchy or slippery, soapy feeling of the skin indicates the presence of caustic soda. TREAT CAUSTIC BURNS IMMEDIATELY. *Call a doctor at once, but proceed with first-aid treatment until a doctor arrives.*

a. EMERGENCY MEDICAL SUPPLIES.

(1) *Before using Generator ML–185–(*), procure from the medical officer the medical supplies listed below.* Place them where they will be readily available when needed.

Boric acid (2 percent), 1 lb box (Medical Corps stock No. 1–106–640).
Ointment: Boric acid in petrolatum (5 percent), ⅛-oz tube, box of 12 (Medical Corps stock No. 1–106–652)
Acetic acid (4 percent) or vinegar
Petrolatum, white, 1 lb (Medical Corps stock No. 1–338–025)
Absorbent cotton
Sterile eye pads and dressings
Toothpicks
Adhesive tape

(2) As a precaution, prepare in quantity, a saturated (4 percent) solution of boric acid. Use approximately 1¼ ounces of boric acid to 1 quart of water. Use only sterile water. Boric acid dissolves more readily in boiling water. Place the solution in a sterile jar with a tight cover. Label the jar and place it with the other medical supplies.

(3) Whenever the generator is to be used, keep a bucket of clean water available so that, in the event of a burn, the chemical or the residue can be washed off quickly.

b. EMERGENCY TREATMENT OF EYE BURNS. *Call a doctor immediately.* Proceed as follows until a doctor comes:

(1) Wash the hands thoroughly before treating a caustic burn.

(2) Have the patient lie on his back. Bathe the affected eyes generously with a lukewarm solution of boric acid (*a*(2) above).

(3) Apply boric acid ointment beneath the eyelid, between the lid and the eyeball. The ointment prevents the eyelid from adhering to the eyeball. A toothpick with a bit of cotton twisted about the end makes a convenient applicator. *Keep supplies sterile.*

(4) Place a sterile eye pad over the eyes, and fasten it in place with adhesive tape. This will keep air from the burn.

(5) As soon as possible, remove the patient to a hospital. If caustic burns on the eyes are not treated at once, loss of sight may result.

c. Emergency Treatment of Skin Burns.

(1) First, flush the affected area plentifully with water. Then bathe it generously with vinegar (4 percent acetic acid); finally, flush it again with water.

(2) Apply vaseline or boric acid ointment to the burned area and cover it with a bandage so the burn will be kept sterile. Get the patient to a doctor as soon as possible.

Section III. OPERATION OF EQUIPMENT UNDER USUAL CONDITIONS

17. Charging Generator ML–185–(*)—Ferrosilicon Process

a. Put on the safety goggles, rubber apron, and rubber gloves.

b. Lock the cylinder in the proper position; this varies with the model of the equipment being used.

(1) *Generator ML–185–A or ML–185–B.* Tilt the cylinder so that the outlet valve assembly is uppermost. Secure the support bar of the proper A-frame of the support in the bar hook opposite it on the other A-frame. Lower the cylinder *gently* onto the crossbar (dropping the cylinder onto the bar will bend the bar). The crossbar now supports the cylinder at an angle of 45° (fig. 10).

(2) *Generator ML–185–C.* With the cylinder hanging upright on the support, secure the support bar of each A-frame in the bar hook opposite it on the other A-frame (fig. 11). This prevents the cylinder from swinging.

c. Open the outlet valve *part way.*

d. Place a funnel in the neck opening of the cylinder. Use the straight funnel when the cylinder is upright (*b*(2) above); use the offset funnel when the cylinder is tilted (*b*(1) above) (the pins on the neck of the cylinder slide into the slotted projections on the neck of the offset funnel).

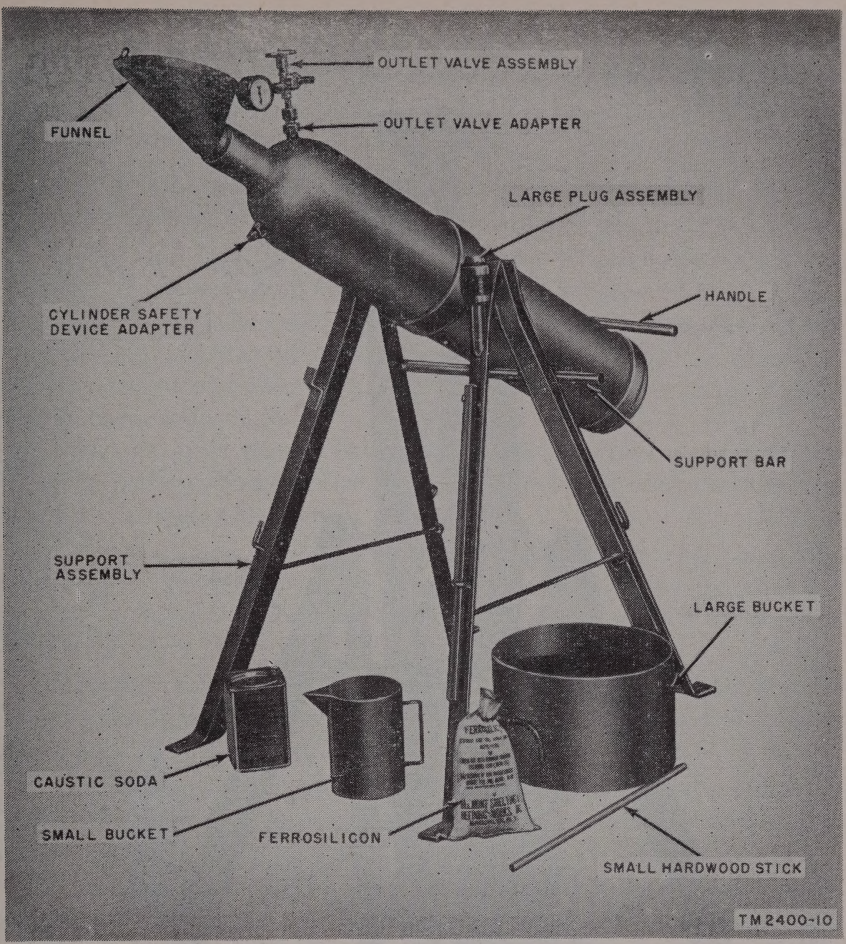

Figure 10. Generator ML–185–A or ML–185–B in inclined charging position.

Caution: Sodium hydroxide can cause serious burns. When handling it, always stand so that any flakes or powder will be blown *away* from the hands, face, and body. Avoid splashing solutions containing sodium hydroxide. Do not handle the residue. For first-aid treatment of caustic burns, refer to paragraph 16.

e. Pour one unit charge (5 pounds or 2.3 kilograms) of sodium hydroxide through the funnel into the cylinder. Use the small hardwood stick to push the flakes through the funnel.

Note. An empty, 5-pound sodium hydroxide container makes a convenient measure if later supplies of the chemical come in bulk. If the can is not wanted for later use, discard it in a covered pit, because cans believed empty may still contain some sodium hydroxide.

f. Measure 4 gallons of water into the large bucket. The upper inside projections on the bucket supplied with Generators ML–185–A

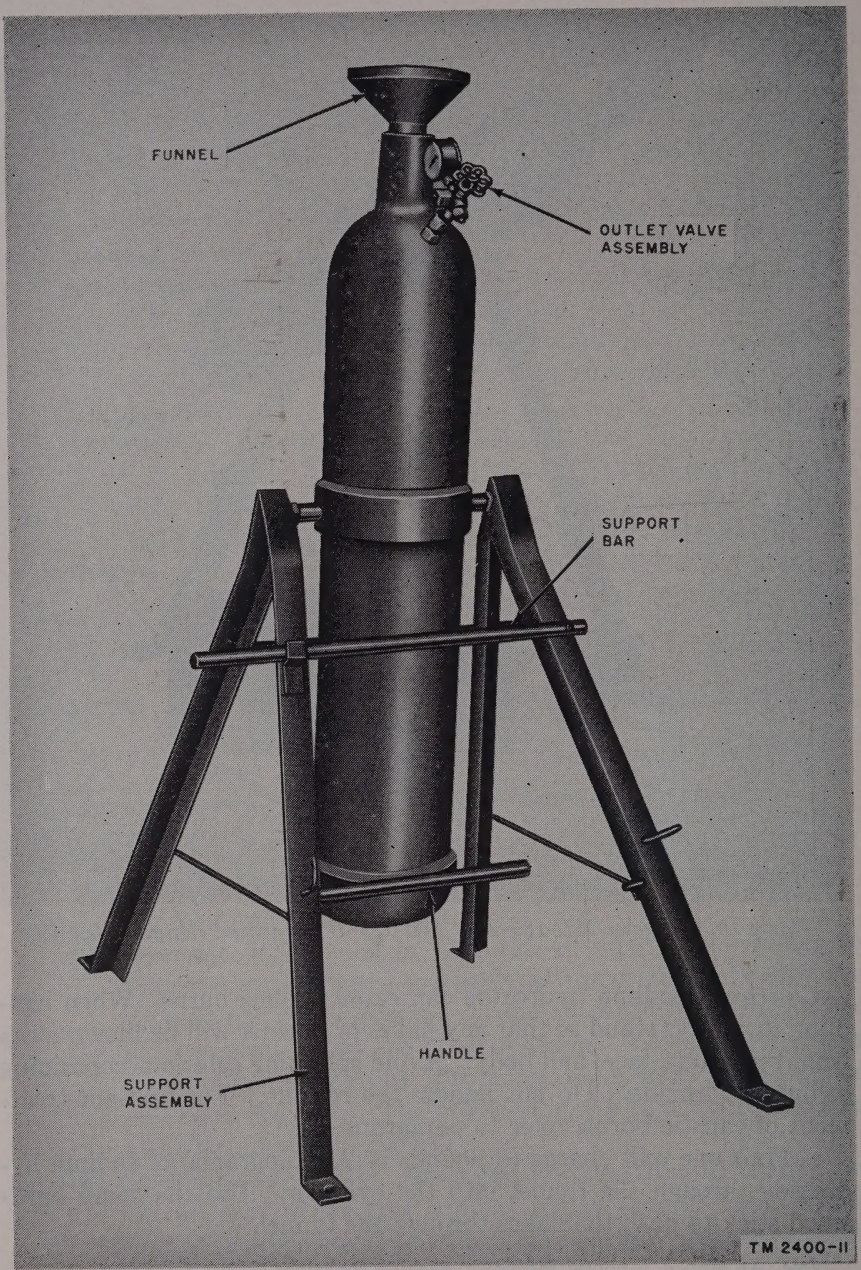

Figure 11. Generator ML–185–C in upright charging position.

and ML–185–B indicate the level to which the bucket must be filled to contain this amount. Fill the bucket supplied with Generator ML–185–C to a level 1½ inches above the inside projections. If a measuring bucket is not available, use 16 quarts or 15 liters of water.

Note. The water should be at least 80°F. (27°C.), preferably warmer. In arctic regions, the water should be hot (par. 23*b*).

g. Using the small bucket, dip up the water and pour it into the cylinder. Save one small bucketful of water (*j* below).

h. Completely dissolve the sodium hydroxide in the water; stir with the long hardwood pole. Completely dissolving the chemical increases the rate of reaction and reduces the possibility of the formation of hardened residues.

i. Pour one unit charge (4½ pounds) of ferrosilicon through the funnel into the cylinder. Use the small hardwood stick to push the chemical through the funnel.

Note. When ferrosilicon is supplied in bulk, mix it thoroughly before measuring a unit charge. Too large a proportion of very small particles in the charge will cause too fast a reaction and excessive pressures; too large a proportion of coarse particles will cause to slow a reaction.

j. Use part of the remaining water (*g* above) to rinse out the funnel. Remove the funnel and use the rest of the water to rinse the threads in the neck of the cylinder. Do this quickly.

k. Immediately screw the large plug into the neck of the cylinder; tighten the large plug *by hand only*; tighten the center screw with the spanner wrench.

l. Open the outlet valve by turning the handwheel counterclockwise. Note the hissing sound of air and gas escaping through the hose coupling. Allow this flow to continue for about 30 seconds to exhaust air from the cylinder; then close the valve. (This process is called *purging.*)

Caution: Do not overtighten the valve with the hand wheel or the valve may lock or freeze. Never use a wrench on the handwheel.

m. The chemical reaction taking place within the cylinder produces large temperature changes which cause stress in the valve. While the temperature is rising, relieve this stress at intervals by opening the valve slightly and closing it immediately.

n. If Generator ML–185–A or ML–185–B is being used, grasp the bar near the base of the cylinder, raise the cylinder slightly, and unhook the support bar. Lower the cylinder until it hangs in an upright position. Secure the support bar in the lower hook on the support frame so the bar will be held out of the way when the cylinder is swung (*o* below). If Generator ML–185–C is being used, remove the support bars from the barhooks and secure the bars against the legs of the A-frames.

o. Agitate the contents of the cylinder.

(1) Using the bar as a handle, raise the end of the cylinder about 45°. Allow the cylinder to swing downward and stop it with a jerk at the bottom of the swing.

Note. When oscillating the cylinder, do not swing it within 30° of the horizontal.

(2) Repeat the process described in (1) above until the reaction is well started. Pressures over 200 pounds per square inch, or a bubbling sound, and heat radiating from the generator, indicate that reaction has started. In cold weather, it may be necessary to shake the cylinder for several minutes. Once the reaction has started, the process continues automatically.

Caution: If the gage indicates a rapid increase in pressure (more than 100 pounds per minute over 1,500 pounds per square inch) instead of a gradual increase, move away from the generator quickly. MOVE FAST!

18. Obtaining Maximum Hydrogen Yield by the Ferrosilicon Process

a. The size of the charge and the ratio of sodium hydroxide to ferrosilicon may be varied to produce a maximum hydrogen yield with a minimum of residue. The most advantageous proportions may be found by experiment.

(1) The size of the charge is correct when the pressure attained is from 1,600 to 2,100 pounds per square inch while the generator is hot, or from 1,200 to 1,500 pounds per square inch when it is cold. If the pressures attained are not within these limits when the charges recommended in paragraph 17*e* and *i* are used, increase or decrease the sizes of the charges in proportion to the amount that the pressures are above or beneath these limits.

(2) The ratio of sodium hydroxide to ferrosilicon is correct when the residue is a gray, liquid sludge with no solids. Clinkers in the residue indicate too great a proportion of ferrosilicon; brown, gummy, difficult-to-remove sludge indicates too great a proportion of sodium hydroxide.

b. The hydrogen yield may be increased by shaking the cylinder vigorously (par. 17*o*(1)) when the pressure apparently has reached a maximum (usually approximately 30 to 60 minutes after the chemicals have been mixed).

19. Charging Generator ML–185–(*)—Aluminum Process

Caution: Do not use Generators ML–185–A and ML–185–B that have not been modified in accordance with MWO SIG 11–2400–1, March 1945, to generate hydrogen by the aluminum process.

a. Put on the safety goggles, rubber apron, and rubber gloves.

b. With the cylinder hanging in an upright position on the support, secure the support bar of each A-frame in the bar hook opposite it on the other A-frame (fig. 11).

c. Open the outlet valve *part way.*

d. Place the straight funnel in the neck opening of the cylinder.

e. Pour one Aluminum Charge ML–389/UM (6¼ pounds of aluminum chips) through the funnel into the generator; use the small hardwood stick to push the chips through the funnel (fig. 12).

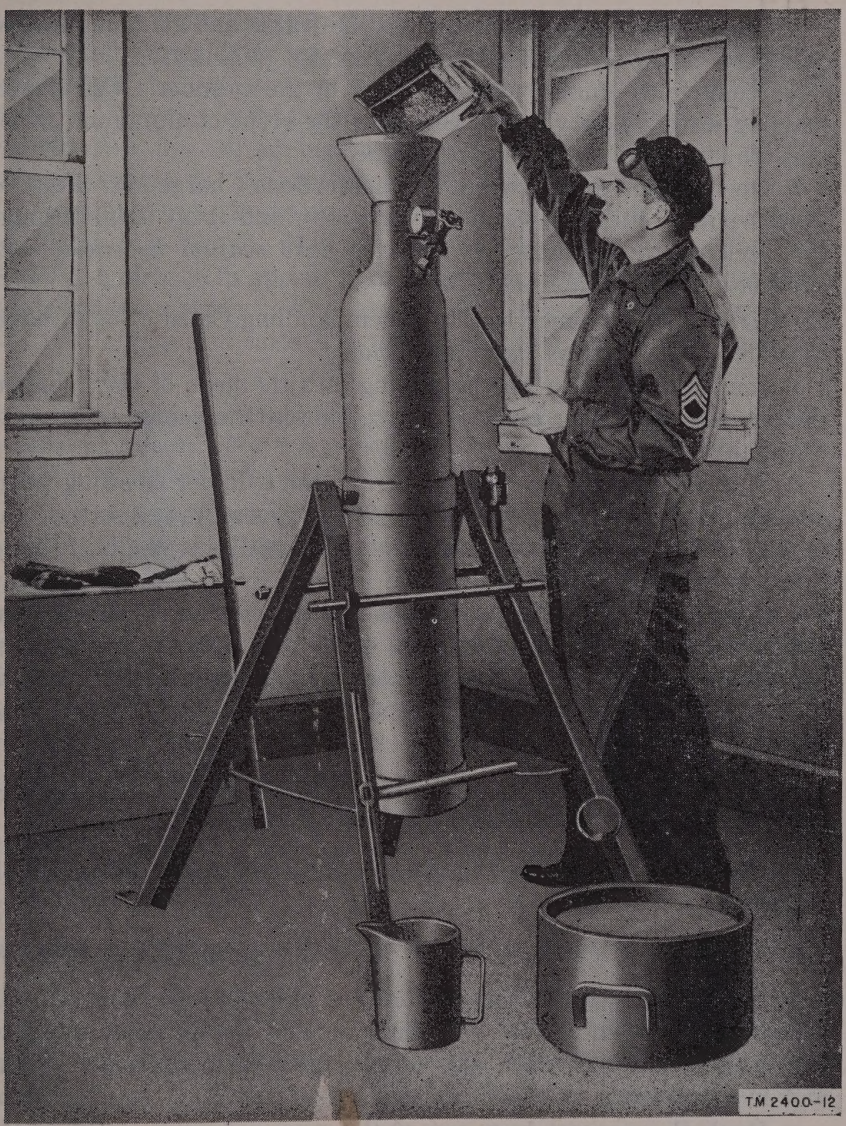

Figure 12. Charging Generator ML–185–(*) with Aluminum Charge ML–389/UM.

f. Measure 3 gallons of water into the large bucket. The angular markers inside the bucket supplied with Generator ML–185–C indicate the level to which the bucket must be filled to contain this amount. Fill the bucket supplied with Generators ML–185–A and ML–185–B to a point 1½ inches below the 4-gallon markers (modified buckets have markers at this 3-gallon point). If a measuring bucket is not available, use 12 quarts or 11⅓ liters of water.

Note. Never use water at a temperature above 130°F. with the aluminum process.

g. Using the small bucket, dip up the water and pour it into the cylinder. Save one small bucketful of water (*h* below).

h. Remove the funnel from the neck of the cylinder. Use the remaining water (*g* above) to wash down the chips of aluminum which may be stuck in the threads of the neck.

i. Open one envelope containing Caustic Soda Charge ML–388/UM (two 1-pound sticks of sodium hydroxide), and drop them through the neck of the cylinder. *Never use flake sodium hydroxide with Aluminum Charge ML–389/UM.*

Caution: Be extremely careful when handling Caustic Soda Charge ML–388/UM. *Always wear rubber gloves.*

j. Immediately screw the large plug into the neck of the cylinder; tighten the large plug by hand only; tighten the center screw with the spanner wrench.

k. Unhook the support bars to permit the cylinder to swing freely and secure them in the lower hooks of the support frames so they will be out of the way. Oscillate the cylinder until gas begins to issue from the outlet valve (par. 17*o*).

l. Open the outlet valve a little more (turn the handwheel counterclockwise). Note the hissing sound of air and gas escaping through the hose coupling. Allow this flow to continue for about 30 seconds to exhaust air from the cylinder, then close the valve. (This process is called *purging.*)

Note. Do not overtighten the valve with the handwheel or the valve may lock or freeze. Never use a wrench on the handwheel.

m. Continue to oscillate the cylinder for 3 minutes after purging it (*l* above).

Note. When oscillating the cylinder, do not swing it within 30° of the horizontal.

n. Secure the support bars so that the cylinder will be held in an upright position and allow it to hang at rest for 30 to 40 minutes. The pressure should reach approximately 1,000 pounds per square inch in this time.

o. Hook the support bars out of the way and again oscillate the cylinder for 5 minutes. Resecure the support bars. After this second

oscillation, reaction will continue automatically. The pressure will begin to rise fairly consistently, and in about 1 hour should reach a maximum pressure of 2,300 pounds per square inch.

Caution: If the gage indicates a rapid increase in pressure (more than 100 pounds per minute over 1,500 pounds per square inch), instead of a gradual increase, move away from the generator quickly. MOVE FAST!

20. Releasing Hydrogen

Hydrogen may be released from Generator ML–185–(*) to inflate balloons with the cylinder in either an inclined or an upright position. To prevent the cylinder from swinging when it is in an upright position, secure the two support bars, one on each side of the cylinder (fig. 11). Use the hydrogen as soon as possible after generation. In cold climates, use the gas before the generator is entirely cool, so that the cylinder can be cleaned before the residue hardens.

a. FERROSILICON PROCESS. When the ferrosilicon process is used, Generator ML–185–(*) produces approximately 85 to 90 cubic feet (STP) of hydrogen in approximately 2 hours. About 15 minutes after the cylinder is charged, 10 to 20 cubic feet of gas may be released for use, if the gage indicates a pressure of 1,000 or more pounds per square inch.

Note. This hydrogen is hot. If hydrogen is released at lower pressures, it may be mixed with steam. Therefore, release *only* 10 to 20 cubic feet and *only* at pressures of 1,000 pounds per square inch or over.

b. ALUMINUM PROCESS. When the aluminum process is used, Generator ML–185–(*) produces approximately 120 cubic feet (STP) of hydrogen in 2¼ hours. Under normal operating conditions, do not use any gas until the reaction has continued for 2¼ hours, when the maximum yield of 120 cubic feet is available. If necessary, hydrogen can be released before the generating process is complete. After 1 hour, 100 cubic feet of hydrogen are available; after 1½ hours (if no gas has been released) 110 cubic feet are available; after 2¼ hours 120 cubic feet are available.

Note. If it can be avoided, do not release hydrogen to inflate balloons while the generator is very hot. A hot generator contains solutions which boil when the pressure is reduced below 500 pounds per square inch. Steam will be carried into the balloon by the hot gas.

21. Inflating Balloons

a. ATTACHING BALLOON. Attach the balloon to a suitable hose cock, the cock to Hose ML–81, and Hose ML–81 to the hose coupling on the generator outlet valve assembly. Detailed instructions for handling and inflating meteorological balloons are given in TM 11–2405.

b. RELEASING HYDROGEN. Open the outlet valve slowly. Turn the handwheel of the valve assembly counterclockwise only a fraction of a turn at a time. Release the gas slowly; the rate of release must not exceed 10 cubic feet per minute.

c. PRECAUTIONS.

(1) Do not release gas too fast. Rapid discharge of hydrogen may build up an electrostatic charge which possibly may cause an explosion. If hydrogen is released too fast from a hot cylinder, the charge may foam and particles of ferrosilicon or aluminum may be carried into the valve assembly and into the balloon being inflated. When the valve is closed, these particles score the valve seat and cause the valve to leak; particles carried into a balloon may pierce it.

(2) Do not release gas too hot. Hot gas carries steam into the balloon; this will reduce the lift. If steam begins to issue from the outlet valve, *close the valve immediately.*

Note. Steam issuing with gas may be detected by the distinctly different sound of the flow. The flow of hydrogen alone is accompanied by a sharp, hissing sound from the valve; the flow of steam by a dull, hollow sound from the cylinder.

d. CLOSING VALVE. When the balloon has been inflated satisfactorily, close and tighten the valve. Turn the handwheel of the valve assembly *by hand only.*

e. EXCESS HYDROGEN. The generator must be cleaned immediately after use. If hydrogen remains after all the required balloons are inflated, transfer the remaining hydrogen to an empty, air-purged cylinder (pars. 37 and 38). If it is known that not all of the hydrogen is to be used at one time, some of it can be transferred to an empty or partially filled cylinder (par. 38) before any gas is used. The balloons can then be filled from the generator and additional hydrogen can be taken from the storage cylinder if necessary. If hydrogen remains in the generator and there is no cylinder available to hold it, discharge it into the air.

Caution: Be sure to discharge hydrogen into the air either out of doors or in an extremely well ventilated place, and only where there is no danger of fire or explosion.

22. Cleaning Generator ML–185–(*)

The cylinder of Generator ML–185–(*) must be cleaned immediately after the generated hydrogen has been used or disposed of (par. 21*e*). If possible, clean the generator while it is still warm; otherwise the residue will solidify (in cold climates it will freeze). Hard clinkers will form and make the cylinder very difficult to clean.

a. Detach the hose from the outlet valve assembly and open the valve fully. Make sure all the gas is released. Partially close and then

reopen the valve several times; this usually permits gas trapped by obstructions, such as water or dirt, to escape through the valve. *Keep the room well ventilated.*

b. After all gas and steam apparently are released, remove the outlet valve assembly (turn it clockwise to unscrew it; it has left-hand threads). Unscrew the valve assembly *slowly,* because the valve may be clogged and may have retained some gas under pressure. Plug the outlet valve adapter with either the brass protector cap or a cork.

c. Using the handle, revolve the cylinder on the trunnions at least 6 times to loosen and mix the residue. Be sure the crossbars are hooked flat against the support legs, out of the way.

Caution: If the outlet valve adapter opening has been closed with a cork, stand so as not to be spattered if the cork is forced out.

d. Place the cylinder in the 45° inclined charging position (fig. 10), and support it with the crossbar.

e. Remove the large plug assembly and place it in the socket on the support. Use the spanner wrench to loosen the center screw by 2 or 3 turns, and use the wrench provided for the purpose to unscrew the plug assembly.

Note. A double-handled, box-type wrench (Signal Corps stock No. 6R55165–81) is useful for loosening plugs that are difficult to remove.

f. Cap the opening in the neck of the cylinder with the cleaning cap assembly (be sure the cap contains a gasket). Engage the cap slots with the pins on the cylinder neck, but do not fasten the cap too tightly or it will be difficult to remove with the chain (*h* below).

g. Place the large bucket beneath the cylinder. Invert the cylinder; be sure the neck opening is directly over the bucket. Fasten the support bars so that the cylinder is held inverted vertically (fig. 13).

Caution: Be sure to wear the safety goggles, rubber gloves, and apron when the next operation is performed.

h. Grasp the free end of the chain attached to the cleaning cap and stand as far from the generator as possible. (By adding a brass wire extension to the chain, the distance can be increased and the danger of being splashed lessened.) Pull the chain so that the cap revolves and is released from the pins; residue will pour into the bucket.

i. Retrieve the cleaning cap. *Use the chain; do not touch the cap with the bare hands.* Rinse the cap thoroughly to remove the caustic residue.

j. Rinse the cylinder with water; hot water may be required to loosen the residue. Use the long hardwood pole to break up clinkers. Never use a steel rod for this purpose; a 6-foot brass rod with a beryllium copper tip (Signal Corps stock No. 7A1694–20) may be used and will be found particularly useful in cold weather for breaking up hardened residue. *The cylinder must be freed completely of all residue.*

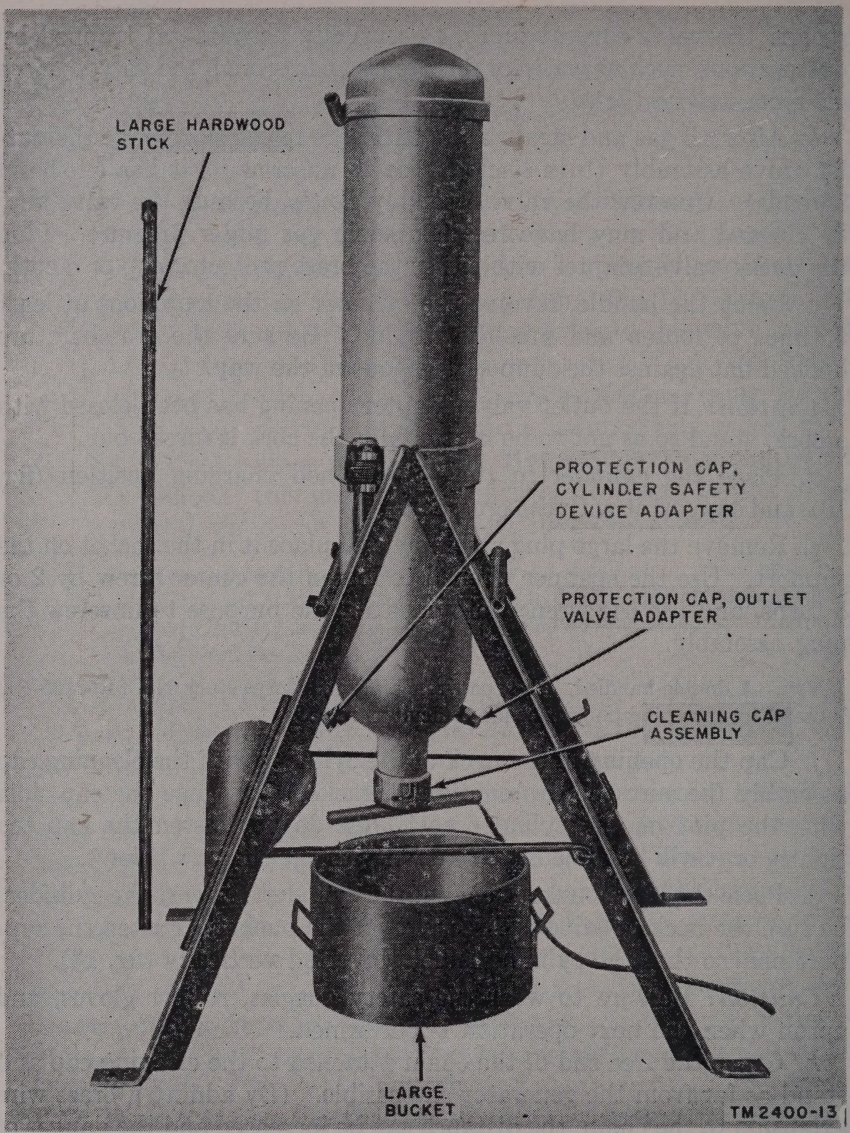

Figure 13. Generator ML–185–(*) inverted for emptying.

(1) Restore the cylinder to an upright position. Pour in a few gallons of water and replace the cleaning cap (*f* above). Oscillate the cylinder to slosh the water inside.

(2) Re-empty the cylinder (*g*, *h*, and *i* above).

(3) Probe the interior of the cylinder with the pole. If the interior does not seem clean, continue to break up the residue and rinse.

(4) Check the volume of the cylinder by filling it with water. If

less than 11⅓ gallons of water fill the cylinder, residue remains in it and further cleaning is required.

k. Dump the waste resulting from the cleaning process into a covered pit or cesspool especially reserved for this purpose.

Caution: The caustic residue which remains after hydrogen has been generated is fatal to plant and animal life. Never dump the residue near or into any water supply used by men or animals. Do not smoke near the residue dump; the residue may continue to react and give off hydrogen for some time.

l. If it is not possible to clean the generator while the cylinder is warm, more solid residue will form and cleaning will be more difficult. The solid residue formed following the use of the aluminum process has the consistency of wet ashes; following the use of the ferrosilicon process, clinkers are characteristic. In either case, vigorous use of the hardwood pole is required to loosen the residue. Follow the cleaning procedure given above. If the residue is extremely difficult to remove, use the method described in paragraph 23*c*(3).

m. Wash and dry the funnels, scoop, buckets, and cleaning cap. Clean the goggles, rubber gloves, and apron.

Section IV. OPERATION UNDER SPECIAL CLIMATIC CONDITIONS

23. Use of Generator ML–185–(*) in Arctic Regions

The general instructions given in paragraphs 17 through 22 apply equally to the use of the generator in the Arctic. However, some special methods and precautions are required in extremely cold climates.

a. SHELTER.

(1) If it is in any way feasible, provide a heated shelter in which to use and store the equipment. The construction and heating of a suitable shelter are discussed in paragraph 10.

(2) In the absence of a heated shelter, protect the generator from the weather as much as possible and modify the operating procedure as indicated in *b* and *c* below.

b. CHARGING. Generate the hydrogen immediately before it is to be used. Preheat the cylinder by filling it with very hot or boiling water and by allowing it to stand for several minutes. Empty the cylinder and repeat if necessary. *Never heat the cylinder with a blow torch.*

(1) *Ferrosilicon process.* Use hot water in the charge; in subzero weather, use boiling water.

Caution: Never use hot or boiling water with the aluminum process.

(2) *Aluminum process.* When the temperature is 0° or lower, add one additional stick of caustic (1 pound, half of one Caustic Soda Charge ML–388/UM) to the charge. This additional pound of caustic increases the temperature of the solution and causes the reaction to take place at the normal rate.

Caution: Do not use an additional stick of caustic when the air temperature is above 0° F.; it would cause a rapid increase in pressure which might blow the safety disks. Exposed sticks of caustic soda absorb moisture from the atmosphere and form a highly corrosive liquid. Store any opened Caustic Soda Charges ML–388/UM in tightly closed, metal containers. If suitable containers are not available, *destroy all exposed caustic.*

c. CLEANING. Use the hydrogen if possible, or transfer it to a storage cylinder (pars. 37 and 38) before the generator becomes cold. Clean the cylinder while the residue is still warm, otherwise the residue will form clinkers and the water within the cylinder will freeze.

(1) Use hot water to rinse the cylinder while the residue is still warm.

(2) When the cylinder cannot be cleaned while the residue is still warm (as at a pilot balloon station), transfer some of the hydrogen to an empty, air-purged cylinder (par. 38). Use as much as possible of the gas remaining in the cylinder, discharge the rest into the air, and clean the cylinder without delay.

(3) Before attempting to remove clinkers, soften them by pouring a few quarts of hot water into the cylinder and adding a small amount of sodium hydroxide. Allow this solution to act on the clinkers for about 30 minutes and then proceed with the normal cleaning operation (par. 22). This method of softening clinkers can be used in any climate.

(4) Clean all the threads thoroughly and dry them.

(5) When the outlet valve assembly, after use outdoors or in an unheated shelter, is brought into a warm room for cleaning, the pressure gage may sweat. To prevent this, place the pressure gage in a rubberized bag and close the neck of the bag with a cord. The gage then will reach room temperature gradually, usually within 30 minutes to 2 hours, and sweating will be minimized. If, in spite of precautions, sweating occurs, dry the gage thoroughly; drying of inaccessible places may be hastened by placing lighted incandescent lamps close to the gage.

(6) Frequently disassemble the outlet valve assembly, clean it thoroughly with hot water, and dry it (par. 46*a*). If the outlet valve has frozen or sticks, thaw out the valve with hot

water. *Never use a wrench to force a valve.* When it is not in use, store the valve assembly in a warm, dry place to prevent the formation of ice in the valve openings. An ice-blocked valve may cause the pressure gage to indicate no pressure when high pressure exists.

24. Use of Generator ML–185–(*) in Tropic Regions

The general instructions given in paragraphs 17 through 22 apply equally to the use of the generator in the Tropics. When the equipment is used out of doors, however, it is desirable to locate it in a shady place and to provide some sort of protection from the weather. Never allow the cylinder to be heated by the sun; excessive and dangerous pressures may result.

CHAPTER 3

MAINTENANCE INSTRUCTIONS

Section I. PREVENTIVE MAINTENANCE SERVICES

25. Meaning of Preventive Maintenance

Preventive maintenance is systematic work performed periodically on equipment to keep it in good working order. Regularly performed, preventive maintenance prevents needless interruptions in service and eliminates the necessity for major repairs. The primary purpose of preventive maintenance is to prevent trouble from occurring.

26. Tools and Materials

When preventive maintenance is performed, have at hand the tools and common materials listed below.

a. TOOLS. All the tools listed below (with the exception of the small brass wire brush and the wrench for the large plug assembly which are not supplied with Generator ML–185–A) are furnished with the equipment.

Brush, brass wire.
Brush, brass wire (for small orifices).
Wrench (for large plug assembly).
Wrench, adjustable.
Wrench, spanner.

b. MATERIALS.

Clean cloths.
Emery cloth.
Grease, general purpose No. 0 (CG–0) or Oil, lubricating, preservative, special (PL-Special) (par. 35).
Solvent, dry-cleaning (SD) (QMC stock No. 51–S–4385–1).
Stiff wire.

Note. Gasoline will not be used as a cleaning fluid for any purpose. Solvent (SD) is available through established channels for use as a cleaning fluid.

27. Openings and Threads

a. Inspect all the openings in the outlet valve assembly and the adapters in the cylinder. Be sure they are clean and free of all residue. Check for obstructions by running a stiff wire through each opening.

Be careful not to damage the needle and the seat in the axial channel of the valve. Inspect the valve assembly, the adapters and protective caps, the cylinder neck opening, the large plug assembly, and the safety devices to see that the threads are in good condition and are free from corrosion. See that no stripping or abrasive action is taking place.

b. Wash all the threads and openings with hot water to remove any residue. Scrub them with the brass brushes, if necessary. Never use steel or iron wire brushes for this purpose.

c. Lubricate the steel threads of the plug assembly and cylinder neck opening sparingly with oil (PL-Special) to prevent rust; grease (CG–0) is satisfactory if the recommended oil is not available.

Note. The standard nomenclature of the above lubricant symbols is given in paragraph 35.

28. Brass Fittings

a. Inspect all fittings to see that they are clean and that no residue has collected. See that none of the parts is damaged or bent.

b. Tighten the brass fittings only if a leak has developed (par. 43). Do not use excessive force on the wrench, or both the threads and the outside surfaces of the nuts may be damaged. When an adjustable wrench is used, fit it snugly on the flats before attempting to turn a nut.

Note. The hose coupling and the outlet valve adapter have *left-hand threads*; all other parts have *right-hand threads.*

c. Clean the brass fittings with a cloth and hot water. Use a brass wire brush if necessary.

29. Outlet Valve Assembly

Completely disassemble and clean the outlet valve assembly and clean the component parts after every 10 or 12 times the generator is used. The cleaning procedure is described in detail in paragraph 46*a* as a repair measure when residue clogs the outlet valve assembly.

30. Cylinder

a. The interior of the cylinder of hydrogen Generator ML–185–(*) must be cleaned immediately after the hydrogen has been used. The procedure for this operation is given in paragraph 22.

b. All residue must be removed from the cylinder.

(1) Inspect the interior of the cylinder by feel; use the long, hardwood pole.

(2) Check the volume of the cylinder. If less than 11⅓ gallons of water fill the cylinder, further cleaning is necessary.

c. Inspect the threads in the neck of the cylinder to see that they are clean and in good condition. Clean them and apply oil (PL–Special) (par. 27*b* and *c*).

d. Wash and dry the exterior of the cylinder if chemicals or residue have splashed or been spilled on it.

31. Gaskets and Washers

Inspect the gaskets in the plug assembly and the cleaning cap assembly, and the washers in the outlet valve assembly and the safety devices to see that they are present and in good condition. Replace any missing, worn, or damaged gaskets or washers.

32. Safety Devices

Inspect the safety devices to see that the disks and washers are in good condition and properly seated. Under normal conditions (pressures from approximately 1,600 to 2,300 pounds per square inch), replace the disks and washers after every five or six uses, or as determined by experience (par. 44*a*). It may be found desirable to use new disks with each charge. Inspect the threads of the retainer cap to be sure they are clean and in good condition.

33. Support

Wipe off the support to remove dirt; wash off any residue that has splashed on it. Inspect the spreader rods and eye hooks and the support bars and barhooks to be sure they are secure. Lubricate with grease (CG–0) the sockets in which the cylinder trunnions rest.

34. Preventive Maintenance Checklist

What to check	When to check	How to check	References (par.)
Exterior of cylinder.	After use.	Inspect to see that it is clean and free from spilled chemicals and residue.	30*d*
	Monthly.	Inspect for rust in scratched places or where paint is worn. (Rusty cylinders must be refinished.)	47
Interior of cylinder.	Immediately after cleaning.	Feel with the long pole to be sure cylinder is clean.	22*j*(3) and (4)
Plug assembly.	Immediately after use.	Inspect to be sure threads are clean and in good condition.	27
Pressure gage.	Before and after use.	Inspect to see that it is in good condition, that the dial glass is unbroken, that the pointer is at zero position, and that the gage is screwed securely into the valve body.	45

34. Preventive Maintenance Checklist—Continued

What to check	When to check	How to check	References (par.)
Regulating and discharge valve.	Immediately after use.	Inspect to see that it is clean and free from obstructions.	46*a*
Safety devices.	Immediately before and after use.	Inspect to see that the disks and washers are in good condition and properly seated, and that threads are clean and undamaged.	32 and 44
Outlet valve.	After use.	Inspect to see that it is clean and that the openings are clear.	27*a*
	After 10 to 12 uses.	Disassemble, inspect, and clean.	29 and 46*a*
Gaskets and washers.	Before and after use.	Inspect to see that they are in good condition and properly seated.	31 and 44*b*
Cleaning cap assembly.	Before and after use.	Inspect for good condition and cleanliness of cap and gasket.	
Fittings.	After use.	Inspect to see that they are clean and undamaged. Tighten if necessary.	28
Support assembly.	Before use.	Check to see that the hooks and bars are securely in place.	
	Monthly.	Inspect for general good condition; clean the support and lubricate the sockets.	33
Gloves, goggles, and apron.	Before and after use.	Inspect to see that they are clean, the goggles unbroken, the gloves and apron untorn.	

Section II. LUBRICATION AND PRESERVATION

35. Lubrication

Generator ML–185–(*) has no moving parts which require lubrication. Grease or oil is applied to the steel threads of the cylinder assembly to prevent rust and corrosion, and the sockets of the support are greased to facilitate the oscillation of the cylinder. A table of lubricants approved for these purposes follows:

Approved symbol	Standard nomenclature
CG–0	Grease, general purpose, No. 0
PL-Special	Oil, lubricating, preservative, special

36. Moistureproofing and Fungiproofing

Moistureproofing and fungiproofing are not required for Generator ML–185–(*). The equipment can be kept in a serviceable condition if it is cleaned as directed in paragraphs 27*b* and *c*, 29, 30*c* and *d*, and 33. In very humid climates, wipe it off occasionally with a dry cloth. When necessary, refinish the cylinder as described in paragraph 47.

CHAPTER 4
AUXILIARY EQUIPMENT

37. Hose ML–216, Description and Use

A high-pressure transfer hose is needed when hydrogen is transferred from Generator ML–185–(*) to a storage cylinder. Hose ML–216 (fig. 14) (Signal Corps stock No. 7A986–216) is designed for this purpose. It is a flexible, braided-copper hose, 8 feet long, provided with a coupling at each end. The couplings are identical and fit both Generator ML–185–(*) and a standard storage cylinder. Hose ML–216 is not furnished with Generator ML–185–(*).

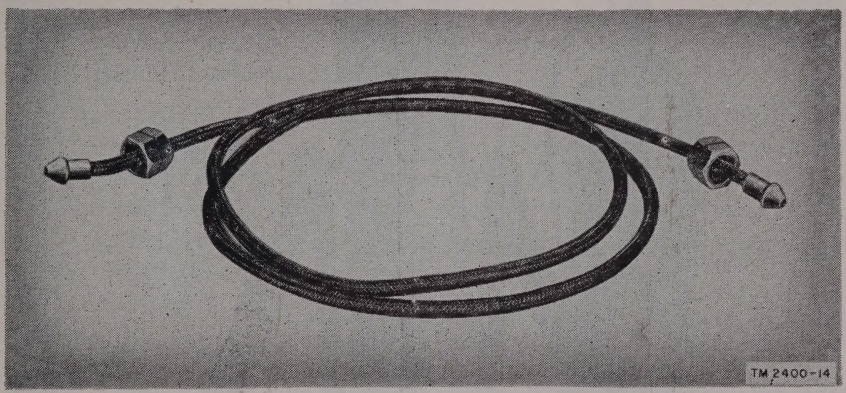

Figure 14. Hose ML–216.

38. Transfer of Hydrogen

a. CONNECTING HOSE ML–216.

(1) Place Generator ML–185–(*) and an empty storage cylinder so that Hose ML–216, when it is connected between them, will hang freely in one plane and without any sharp bends or twists (fig. 15).

(2) Remove the hose coupling from the outlet valve assembly of the generator and connect one coupling of Hose ML–216 directly to the outlet valve assembly body.

(3) Connect the other coupling of Hose ML–216 to the storage cylinder. If a standard hydrogen storage cylinder is being used, connect the transfer hose directly to the outlet valve on the cylinder. If the empty cylinder of a Generator ML–

185–(*) is being used for storage, install the outlet valve assembly, remove the hose coupling from the outlet valve assembly, and connect Hose ML–216 directly to the outlet valve body. In either case, tighten the coupling *by hand only.*

(4) Check the hose to be sure it hangs freely in one plane and without kinks. Adjust the position of the storage cylinder if necessary.

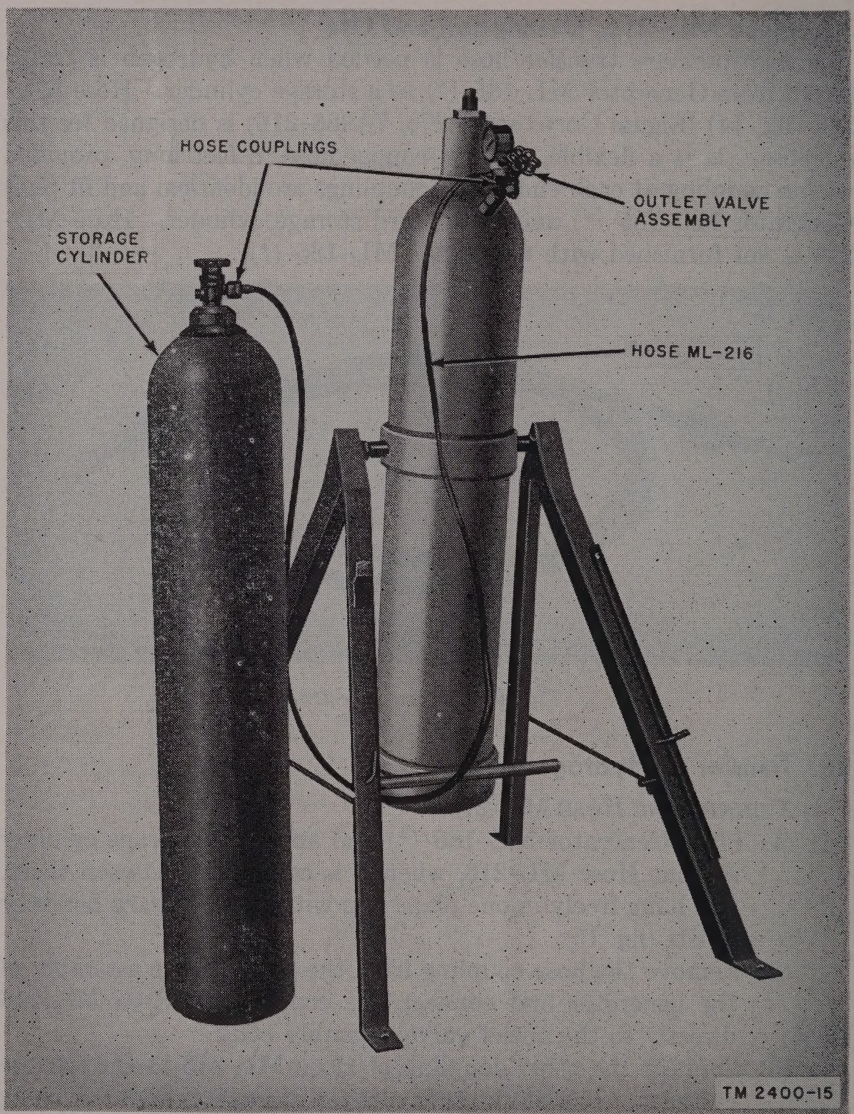

Figure 15. Transferring hydrogen to storage cylinder.

b. PURGING TRANSFER HOSE AND STORAGE CYLINDER.

(1) *Fully* open the valve of the storage cylinder.

(2) *Partly* open the valve of the full generator; do this slowly. Do not open the valve wide; hydrogen must flow slowly into the storage cylinder. Note the pressure indicated by the gage of the full generator.

(3) When the gage indicates that the pressure within the generator has fallen 15 to 20 pounds per square inch, close the outlet valve of the generator.

(4) *Loosen* the hose coupling (*do not remove it*) on the storage cylinder and permit gas and air to escape slowly. Retighten by hand the coupling on the storage cylinder.

(5) Repeat several times the operations described in (2), (3), and (4) above,

(6) Tighten both hose couplings with a wrench. The storage cylinder now is largely purged of air and the transfer of hydrogen can begin.

Note. When hydrogen is transferred to a storage cylinder already containing some gas, omit the procedure for purging transfer hose and storage cylinder.

c. TRANSFERRING HYDROGEN TO PURGED STORAGE CYLINDER.

(1) With the valve of the storage cylinder fully open, *slowly* open the outlet valve on the generator; open it only part way. *Do not open the valve on the generator sufficiently to permit a rapid transfer of hydrogen.* Hydrogen will flow from the generator into the storage cylinder.

Note. If a leak from the valve gland becomes apparent, ignore it until after the transfer of hydrogen is complete. Fix the leak later (par. 43).

(2) Watch the pressure gage on the generator. When the indicated pressure ceases to fall and remains constant, close the valves on the generator and on the storage cylinder.

Note. About 60 percent of the gas can be transferred from a full generator to an empty storage cylinder of the same size.

(3) Slowly loosen the couplings and remove Hose ML–216 from the generator and the storage cylinder. Do this carefully; there is gas under pressure within the hose.

CHAPTER 5

FIELD MAINTENANCE

Section I. THEORY OF EQUIPMENT

39. Physical Design and Technical Characteristics

Generator ML–185–(*) is designed to provide complete equipment for generating hydrogen gas to inflate meteorological balloons. A list of the components of the equipment is given in paragraph 7; a physical description of each major component is given in paragraph 4; the accessory equipment is described in paragraph 5; paragraph 8 summarizes the technical characteristics of the equipment.

40. Characteristics and Production of Hydrogen Gas

Hydrogen is the lightest gas known. It is colorless and odorless; when pure, it burns quietly; when mixed with air in certain proportions and heated, it explodes violently. Certain elements, among them aluminum and silicon, will react with a water solution of sodium hydroxide to liberate hydrogen. Hydrogen gas is produced in the cylinder of Generator ML–185–(*) by the reaction of measured amounts of sodium hydroxide, water, and either ferrosilicon or aluminum, combined in the cylinder which then is sealed to confine the hydrogen liberated by the chemical reaction.

a. Hydrogen Prepared by the Reaction Between Ferrosilicon and Sodium Hydroxide. The element silicon (Si) reacts with a water (H_2O) solution of sodium hydroxide (NaOH) to form sodium silicate and to liberate molecular hydrogen (H_2). The reaction is expressed by the equation $Si + 2NaOH + H_2O \rightarrow Na_2SiO_3 + 2H_2$. The equation, expressed in words, reads: one atom of silicon reacts with two molecules of sodium hydroxide and one molecule of water to form one molecule of sodium silicate (Na_2SiO_3) and to liberate two molecules of hydrogen. The equation is based on pure ingredients; quantitatively, it indicates that one pound of silicon will react with 2.86 pounds of sodium hydroxide (and sufficient water) to liberate 27.0 cubic feet of hydrogen (if the volume of the hydrogen is measured at standard conditions of temperature and pressure). In practice, ferrosilicon is used in place of the element silicon, and the proportion of sodium hydroxide to ferrosilicon is smaller than that indicated by the

equation. The ferrosilicon usually employed contains approximately 80 percent silicon, and the silicate (or silicates) produced may be more complex than that shown. The reaction between the ferrosilicon and sodium hydroxide proceeds satisfactorily only when the temperature of the reactants (or of the mixture) is about 130° F., or higher. When solid sodium hydroxide dissolves in water, heat is generated (the heat of solution); usually, this heat is sufficient to raise the temperature of the mixture to the starting temperature of the reaction; in cold climates, it may be necessary to preheat the water so that the mixture temperature may be high enough to start the reaction. The chemical reaction also generates heat; this heat of reaction is enough to maintain the reaction, and often it is enough to raise the temperature of the mixture so high that the liberated hydrogen must be cooled before it is used.

b. HYDROGEN PREPARED BY THE REACTION BETWEEN ALUMINUM AND SODIUM HYDROXIDE. Aluminum (Al) reacts with a water solution of sodium hydroxide to form sodium aluminate and to liberate hydrogen. The chemical reactions involved are complex. The heat of reaction (*a* above) is sufficiently great that the temperature of the mixture becomes high; at high temperatures several intermediate reactions occur, a discussion of which, and of the products so formed, is not essential to a working knowledge of Generator ML–185–(*). The end result may be represented by the equation $2Al + 2NaOH + 2H_2O \rightarrow 2NaA10_2 + 3H_2$. The equation, expressed in words, reads—two atoms of aluminum react with two molecules of sodium hydroxide and two molecules of water to form two molecules of sodium aluminate ($2NaA10_2$) and to liberate three molecules of hydrogen. Quantitatively, 1 pound of pure aluminum will react with 1.48 pounds of sodium hydroxide (and sufficient water) to liberate 42.0 cubic feet of hydrogen (if the volume of the hydrogen is measured at standard conditions of temperature and pressure). In practice, the yield of hydrogen may differ, somewhat, from the theoretical quantity. The heat of solution (*a* above) is sufficient to raise the temperature of the mixture to the starting temperature of the reaction. It is unnecessary to preheat the water; water above 130° F. never should be used.

Section II. REPAIR

41. Trouble Shooting

Most troubles which necessitate the repair or replacement of parts of Generator ML–185–(*) can be determined by observation during charging or while the generator is in operation. Difficulty in engaging threads during assembly indicates stripping, corrosion, or rust. Leaks may be located by the hissing sound of escaping gas. Pressures consistently higher than normal probably are caused by insufficient cleaning of the cylinder after use.

Caution: Never attempt to repair Generator ML–185–(*) while any gas under pressure remains in the cylinder.

42. Trouble-Shooting Chart

Trouble	Possible cause	Corrective action	References (par.)
Consistently excessive pressures.	Residue, due to insufficient cleaning, remaining in cylinder.	Clean cylinder thoroughly; check capacity.	22
Threads bind or engage with difficulty.	Residue on threads.	Clean and lubricate threads.	27*b*, *c*
	Threads corroded or rusted.	Clean and lubricate threads.	27*b*, *c*
	Threads stripped.	Replace part.	
Leaking connections.	Check for looseness.	Tighten fitting.	28*b*
	Inspect washers.	Replace worn washers.	44*b*
	Inspect safety disks.	Reseat or replace disks.	44*a*
	Examine equipment for residue or dirt.	Clean.	27, 28, 29
Leaking outlet valve.	Scored valve seat.	Ream valve seat.	46*b*
	Scored needle.	Turn needle on lathe; replace if badly scored.	46*b*
	Inspect washers.	Replace worn washers.	44*b*

43. Leaks

A hissing sound of gas escaping anywhere except through the valve is evidence of a leak. The location of a leak usually can be determined by ear. If a leak is noted while the generator is in use, locate the leak, *but do not attempt to stop it.* Particularly, do not tighten the safety devices unless they obviously are loose. The disks may be distorted and may blow immediately; the operator is then in serious danger of being spattered. Proceed as follows:

a. Note the location of the leak but ignore it. Probably enough pressure will be retained to permit the use of some of the gas.

Caution: Keep the room well ventilated. Be especially careful of fire.

b. Use as much of the gas as possible and allow the leak to continue until the pressure ceases to drop. *Never release gas from a leaking cylinder by opening the outlet valve wide.* The cold produced by the expanding gas may cause the valve to ice up.

c. When it is certain that no gas under pressure remains in the cylinder, clean the cylinder (par. 22).

d. Repair the leaking part. For the causes and correction of leaks, refer to paragraph 42.

Note. Worn washers or improperly seated disks cause leaks. Do not attempt to stop a leak by tightening the cap or fitting; the threads are stripped easily. Replace the washer; reseat or replace the disk (par. 44*a*).

44. Replacement of Parts

a. SAFETY DISKS. Replace safety disks after being used five or six times.

(1) Remove the safety device that contains the disk to be replaced. Pry out the washer and remove the old or blown disk.

(2) Use a small piece of wire to remove any residue that has collected in the retainer and sleeve.

(3) Place a new disk in the cap and install a new fiber washer on top of the disk. Seat the disk and washer carefully.

Caution: Safety disks are thin and may stick together. Be certain to install only *one disk* in the cap.

(4) Tilt the cylinder so the safety device adapter points downward and screw the safety device securely into place. Be careful not to damage the threads of the retainer by overtightening it.

(5) If a new safety disk is not available, a used but unblown disk may be used in an emergency. A used safety disk is bent into a slightly concave shape (do not use badly distorted disks). Place the used disk in the cap in the exact position it had before it was removed. Be sure the convex surface of the disk is *outward.*

Caution: Never place a used disk so that gas under pressure is applied to the convex side. The pressure will flex the disk and greatly weaken it so that it will blow at less than its rated pressure.

b. RUBBER WASHERS. Replace the rubber washers in the main plug assembly and the cleaning cap assembly when they show roughness or evidence of hard use. Remove the washers if the generator is to be stored for any length of time.

45. Adjustment of Pressure Gage

a. Excessive pressure may move the pointer of the pressure gage against the stop at the upper limit of the scale thus preventing the pointer from returning to zero when there is no pressure within the cylinder. Remove the glass cover of the dial and gently move the pointer back to zero position. Replace the glass.

Caution: Do not force the pointer if it sticks. Moisture within the gage may have frozen (*b* below).

b. In very cold weather, the pointer on the gage may remain at a high-pressure position because moisture within the gage has frozen.

Thaw out the gage by placing lighted electric lamps close to it until the pointer returns to zero position. *Do not use a blow torch to thaw out the gage.*

46. Repair of Outlet Valve Assembly

a. CLOGGED VALVE. If hardened residue clogs the outlet valve assembly, the valve must be disassembled and cleaned thoroughly.

(1) Remove the pressure gage, safety device, and hose connection. Then completely disassemble the valve into its component parts. Refer to figure 5. Do not use too much force on the wrench. If the valve is difficult to disassemble, soak it in hot water to loosen the residue.

(2) Clean all parts thoroughly; scrub them with hot water and a brass brush. Run a stiff wire through all openings to free them from obstructions.

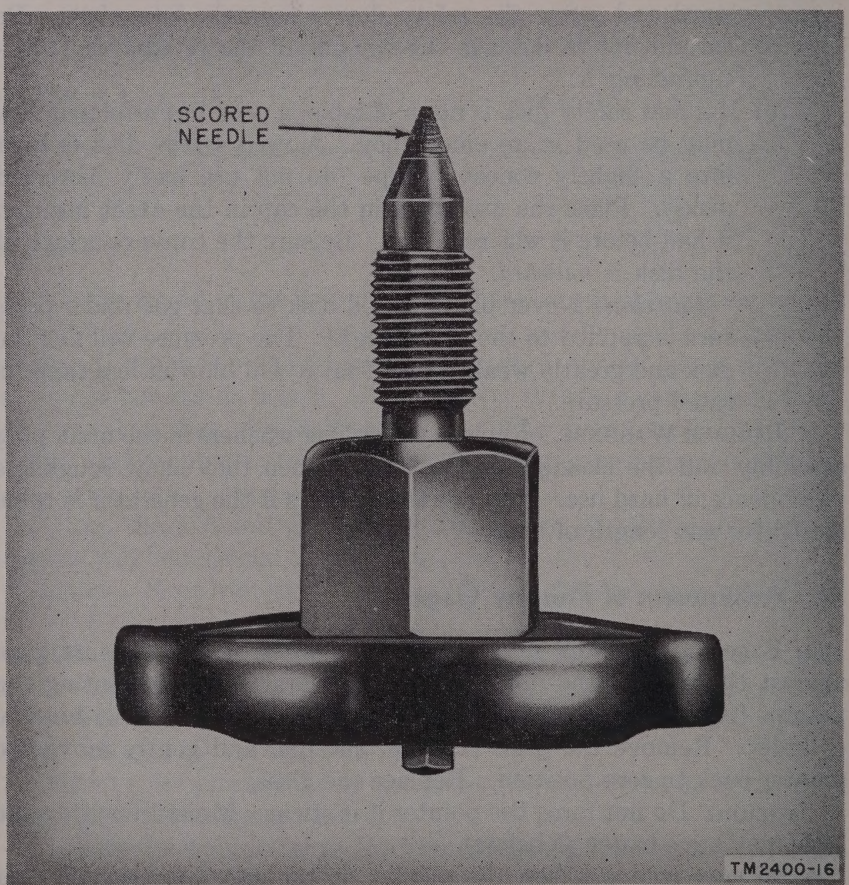

Figure 16. Scored needle on valve stem.

(3) Inspect all threads to be sure they are clean and in good condition. Inspect the valve needle and seat for evidence of scoring. If necessary, repair them as described in *b* below.

(4) Reassemble the valve. Be careful to replace the washers in the proper locations (fig. 5); if washers are badly worn, install new washers.

b. SCORED NEEDLE AND VALVE SEAT (figs. 16 and 17). A scored needle may be turned on a lathe; replace badly scored needles. A scored valve seat should be reamed.

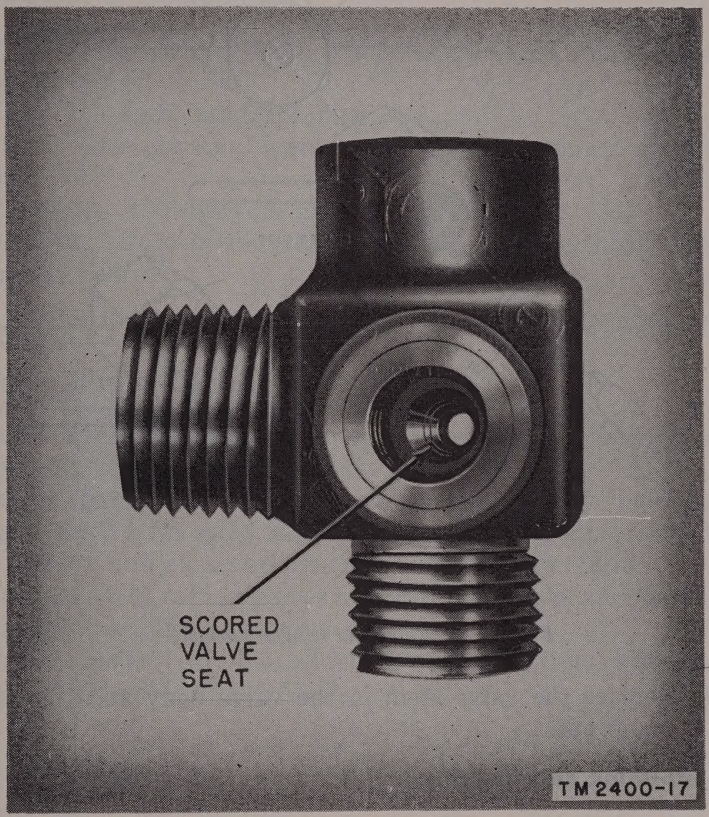

Figure 17. Scored valve seat in outlet valve body.

(1) Loosen the valve gland nut and remove the valve stem from the assembly. Secure the valve body in a vise.

(2) Insert the reamer of the valve seat reamer assembly (fig. 18) into the valve seat opening, slip the thrust washer onto the stem of the reamer, and screw up the reamer guide nut until it is just tight.

(3) Turn the reamer wrench handle 2 complete revolutions.

(4) Retighten the reamer guide nut and again turn the wrench handle through 2 complete revolutions.

(5) Loosen the reamer guide nut and remove the reamer. Clean out the valve seat and opening thoroughly.

(6) Examine the valve seat. If it is not smooth, repeat the process described in (2), (3), (4), and (5) above.

Caution: Do not ream the valve seat unless it is necessary. Repeated reaming gradually will remove so much metal that the valve will be unfit for use.

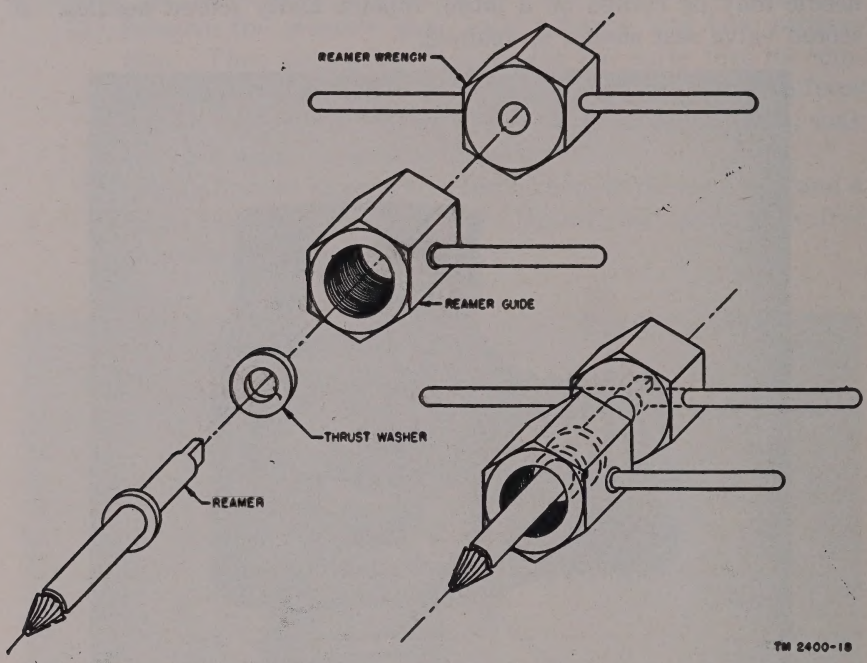

Figure 18. Valve seat reamer assembly.

(7) Replace the valve stem in the valve body and tighten the gland nut.

47. Refinishing and Painting

Generators or storage cylinder which have rusted where the paint is scratched or worn off must be cleaned and refinished.

a. Use emery cloth or No. 0000 sandpaper to clean all rusty places. Rub until the bare metal is exposed and bright.

b. Wash the cleaned areas with solvent (SD) (par. 26*b*).

c. Apply one coat of red lead paint to the *bare* steel surfaces. Allow it to dry overnight.

d. Repaint the *entire cylinder* with semigloss, olive drab, air-drying enamel.

CHAPTER 6

DEMOLITION TO PREVENT ENEMY USE

48. Methods of Demolition

a. SMASH. Use sledges, axes, handaxes, pickaxes, hammers, crowbars, heavy tools.

b. CUT. Use axes, handaxes, machetes.

c. BURN. Use gasoline, kerosene, oil, flame throwers, incendiary grenades.

d. EXPLODE. Use firearms, grenades, TNT.

e. DISPOSE. Bury in slit trenches, fox holes, other holes. Throw in streams. Scatter.

Note. Use anything immediately available for destruction of this equipment.

49. Destruction of Components

When ordered by your commander, destroy all equipment to prevent its being used or salvaged by the enemy.

a. Smash (par. 48*a*) the outlet valve assembly, safety device assemblies, adapters, large plug assembly, support assembly, hardwood sticks, goggles, and all accessories and running spare parts.

b. Cut (par. 48*b*) rubber gloves and apron, gaskets, and washers.

c. Explode (par. 48*d*) the cylinder.

d. Bury or scatter (par. 48*e*) all remaining parts of the equipment.

e. DESTROY EVERYTHING.

APPENDIX I

REFERENCES

Note. For availability of items listed, check SR 310–20–3 for field manuals and JANAP's. Check SR 310–20–4 for technical manuals, technical bulletins, supply bulletins, and modification work orders.

1. Manuals, Bulletins, and Modification Work Orders

FM 4–193	Antiaircraft Artillery: Barrage Balloon, Gas Generation, Use, Purification, and Service of Hydrogen Generator.
MWO SIG 11–2400–1	Modification of Generators ML–185, ML–185–A, and ML–185–B. (Hydrogen) to permit use of aluminum and sodium hydroxide process.
SB 11–47	Preparation and Submission of Requisitions for Signal Corps Supplies.
TB SIG 123	Preventive Maintenance Practices for Ground Signal Equipment.
TM 3–250	Storage and Shipment of Dangerous Chemicals.
TM 8–285	Treatment of Casualties from Chemical Agents.
TM 11–2405	Meteorological Balloons.

2. Military (JAN) Specifications

a. Packaging and Packing for Overseas Shipment—

JAN–P–100 General Specifications.

JAN–P–116 Preservation, methods of

b. U. S. Army Specifications.

100–2E Marking Shipments by Contractors, standard specification for

c. Signal Corps Instructions.

720–7 Standard Pack.

726–15 Marking of Interior Containers (for Signal Corps Equipments).

3. Other Publications

SR 310–20–3	Index of Training Publications (Field Manuals, Training Circulars, Firing Tables and Charts, Army Training Programs, Mobilization Training Programs, Graphic Training Aids, Joint Army-Navy-Air Force Publications, and Combined Communications Board Publications).
SR 310–20–4	Index of Technical Manuals, Technical Regulations, Technical Bulletins, Supply Bulletins, Lubrication Orders, Modification Work Orders, Tables of Organization and Equipment, Reduction Tables, Tables of Allowances, Tables of Organization, and Tables of Equipment.
SR 310–20–5	Index of Administrative Publications (Army Regulations, Special Regulations, Readjustment Regulations, Joint Army-Air Force Adjustment Regulations, General Orders, Bulletins, Circulars, Commercial Traffic Bulletins, Joint Procurement Circulars, Department of the Army Pamphlets, and ASF Manuals).
SR 310–20–6	Index of Blank Forms and Army Personnel Classification Tests.
SR 700–45–5	General—Unsatisfactory Equipment Report (Reports Control Symbol CSGLD–247).
SR 745–45–5 NAV DEP SERIAL 85P00 ARF–71–4	Report of Damaged or Improper Shipment (Reports Control Symbols CSGLD–66 (Army), SandA–70–6 (Navy), and AF–MC–U2 (Air Force)).

APPENDIX II

IDENTIFICATION TABLE OF PARTS

1. Requisitioning Parts

The fact that a part is listed in this table is not sufficient basis for requisitioning the item. Requisitions must cite an authorized basis, such as the specific T/O&E, T/A, SIG 7 & 8, SIG 7–8–10, SIG 10, List of Allowances of Expendable Material, or another authorized supply basis. The Department of the Army Supply Catalog applicable to the equipment covered in this manual is, SIG 7 & 8–ML–185. For an index of available supply catalogs in the Signal portion of the Department of the Army Supply Catalog, see the latest issue of SIG 1. Department of the Air Force requisitions should be initiated for maintenance items in accordance with Air Force Manual 67–1 and Applicable Technical Order 16–55–431.

2. Identification Table of Parts

Fig. ref	Name of part and description	Function of part	Signal Corps stock No.	A.F. stock No.
2	GENERATOR ML–185–(*): hydrogen; steel cylinder 56″ lg x 9 9/16″ OD; internal vol approx 2600 cu in.; complete with plug, outlet valve, pressure gage; safety devices, support, accessories, and tools.	Used to generate hydrogen gas to inflate meteorological balloons.	7A975–85	2600–701 951 800
10	ADAPTER, valve: outlet; brass; 1 7/8″ lg x 1 1/8″ wd; 7/32″ dia hole through center; rh thd both ends.	Connects safety devices to cylinder	7A975–85/T2	2600–702 056 000
10	ADAPTER, valve: outlet; brass; 2 3/8″ lg x 1 1/8″ wd; 1/4″ dia hole through center; rh thd one end, lh thd other end.	Connects outlet valve assembly to cylinder	7A975–85/T1	2600–702 052 000
2	APRON MC–111: black, acid-proof rubber; 50″ lg x 32″ wd.	Protects operator from caustic soda solution	6Z411	Requisition Sig. Corps
4	BODY, valve: outlet; bronze; 2 1/8″ wd x 2 11/16″ lg x 1 11/16″ dia; five threaded outlets.	Houses needle valve and outlet valve and mounts pressure gage and safety device.	7A975–85/B6.1	2600–701 968 110
	BOLT, stove: 1 1/2″ lg, 1/4″ dia head; rh thd; includes nut and washer.	Secures rubber washer in cleaning cap	7A975–85/B2	2600–701 956 000
2	BRUSH, cleaning: oblong; brass wire; 8 1/2″ lg x 5/8″ wd x 1/2″ thk.	Used to clean threads	7A975–85/B3	2600–701 960 000
2	BRUSH, cleaning: round; brass wire; 4 5/8″ lg x 1 1/2″ dia.	Used to clean outlet valve assembly	6Z1415–2	2600–695 488 570
2	BUCKET: steel; measuring; 8″ h x 6 1/8″ OD; with markers.	Used to measure and pour chemicals and water.	7A975–85/B5	2600–701 968 000
2	BUCKET: steel; measuring; 8 3/4″ h x 15 1/8″ ID; with markers.	Used to measure water and to receive residue	7A975–85/B4	2600–701 964 000
13	CAP: adapter; brass; 7/16″ h x 13/16″ across flats; threaded.	Protects thread of cylinder safety device adapter.	7A975–85/C7	2600–701 988 125

2. Identification Table of Parts—Continued

Fig. ref	Name of part and description	Function of part	Signal Corps stock No.	A.F. stock No.
13	CAP: adapter; brass; 9/16″ h x 1 1/16″ across flats; threaded.	Protects thread of outlet valve adapter.	7A975–85/C1	2600–701 972 000
13	CAP: cleaning; mild steel; 3 3/16″ h x 3 3/4″ dia; slotted; bar 11″ lg welded to top; includes chain, bolts, and washer.	Used to close cylinder neck opening during cleaning process.	7A975–85/C4	2600–701 984 000
4	COUPLING: rigid; nipple with tapered gland; threaded; tobin bronze; 2 1/8″ lg x 23/32″ dia; 11/64″ dia center hole.	Connects outlet valve to hose	7A975–85/C9.1	2600–701 988 210
4	DISK: safety device; pure nickel; 19/32″ dia; bursting pressure 3000 to 3700 psi at 212°F.	Used in cylinder and valve safety devices to relieve excessive pressures.	7A975–85–4	2600–702 092 500
2	FUNNEL: iron; angle shape	Used to facilitate pouring chemicals and water into the cylinder.	7A975–85/F1	2600–702 012 000
11	FUNNEL: iron; cone shape; 9″ max dia; 11 1/2″ lg o/a.	Used to facilitate pouring chemicals and water into cylinder.	7A891	2600–701 894 000
4	GAGE, pressure: gas; dial and pointer type; range 0 to 3000 psi.	Indicates pressure of gas within the cylinder	7A975–85/G1	2600–702 016 000
2	GLOVES: rubber; acid-proof; size 11; 18″ lg	Protect hands and arms of operator	QMC73G37011[a]	Requisition QM #73–G–37011
2	GOGGLES TL–547/U: safety; colorless lens	Protect eyes of operator	6Z4841	2600–702 020 000
18	GUIDE, reamer: brass and steel; 3 1/4″ lg x 1 1/4″ wd x 1 1/16″ thk.	Part of valve seat reamer assembly	7A975–85A/G1	2600–702 100 100
5	HANDWHEEL: valve stem; bronze, white metal dip; 2 5/8″ dia o/a with 15/64″ dia center hole.	Controls the valve stem	7A975–85/H1	2600–702 021 000
	NUT, hexagon: brass; 3/4″–20 USF thd; 13/16″ thk, 15/16″ wd across flats.	Used as packing nut on valve stem	7A975–85/N3	2600–702 026 200
	NUT, hexagon: brass; .838″–14 lh USF thd; 15/16″ thk, 1 1/8″ wd across flats, with 9/16″ dia hole.	Used to tighten hose coupling	7A975–85/N1	2600–702 026 000

[a] Quartermaster Corps stock number.

4	NUT, hexagon: brass; .838″–14 lh USF thd; 15/16″ thk, 1 1/8″ wd across flats, with 5/8″ dia hole.	Outlet valve connecting nut	7A975–85/N4	2600–702 026 400
	NUT, lock: brass; 1/4–27 thd; 3/16″ thk, 7/16″ wd across flats.	Secures handwheel on valve stem	7A975–85/N2	2600–702 026 100
5	OUTLET NEEDLE VALVE ASSEMBLY: valve body with stem and handwheel; brass and bronze; 5 1/4″ lg o/a.	Controls the flow of gas through the outlet valve.	7A975–85A/O1	2600–702 100 320
	PIN, straight: steel; 2 1/2″ lg x 7/32″ dia	Connects center screw and seal of large plug assembly.	7A975–85/P4	2600–702 026 750
	PIN, straight: steel; 2″ lg x 1/4″ dia	Secures funnel and cleaning cap to cylinder neck.	7A975–85/P2	2600–702 026 690
3	PLUG ASSEMBLY, machine thread: CRS, nickel plated; 5 1/2″ h x 2 3/4″ dia; includes center screw seal and pins.	Closes cylinder neck opening during operation of the generator.	7A975–85/P1	2600–702 026 640
18	REAMER, taper: fixed, spiral flutes; 3/8″ to 1/16″ x 7/16″ cutting edge; tool steel; 3 3/16″ lg o/a.	Part of valve seat reamer assembly	7A975–85A/R1	2600–702 100 340
18	REAMER ASSEMBLY, taper: steel and brass; consists of reamer, guide, wrench, and washer.	Used to ream out scored seat of outlet valve	7A975–85A/R2	2600–702 100 345
	RETAINER, disk: brass; 9/16″ thk x 7/8″ wd across flats; 13/32″ dia opening.	Contains sleeve, disk, and washer of safety device.	7A975–85/C3	2600–701 980 000
3	SCREW, adjustment: headless; CRS, nickel plated; 1 1/8″–12 US std thd; 4 1/2″ lg, threaded approx 2 1/16″.	Center screw for tightening seal of large plug assembly.	7A975–85/S1	2600–702 032 000
2	SCOOP: feed; CRS, olive drab; 8 1/2″ lg x 3 9/16″ wd, approx.	Used to scoop chemicals into measuring container.	7A975–85/S5	2600–702 048 000
5	SLEEVE, coupling: brass; 9/16″ lg x .610″ dia; 3/16″ hole in side.	Blow-off discharge outlet of safety device	7A975–85/S8	2600–702 048 150
	SLEEVE, coupling: brass; 2 1/2″ lg x 23/32″ dia; 9/32″ center hole.	Attaches hose to outlet valve assembly	7A975–85/S7	2600–702 048 100
5	STEM, valve: outlet; stainless steel; 2 13/16″ lg o/a	Part of outlet valve assembly	7A975–85/S9.1	2600–702 048 165
2	STICK, hardwood: maple or oak; 24″ lg x 1/2″ dia	Used to push chemicals through funnel	7A975–85/S4	2600–702 044 000
2	STICK, hardwood: maple or oak; 60″ lg x 15/16″ dia; tapered bronze tip 2 1/4″ lg.	Used to break up residue during cleaning operation.	7A975–85/S3	2600–702 040 000

2. Identification Table of Parts—Continued

Fig. ref	Name of part and description	Function of part	Signal Corps stock No.	A.F. stock No.
2	STOPPER: cork; tapered cylinder 7/16″ max dia x 21/32″ lg.	Closes safety device and outlet valve adapter openings during cleaning operation.	6Z8420–3	Requisition Sig. Corps
	STUD: CRS, nickel plated; 1 5/8″ h x 2 1/2″ dia; two holes, ea .870″ dia.	Part of large plug assembly; seals cylinder neck opening.	7A975–85/S6	2600–702 048 050
4	VALVE ASSEMBLY: outlet brass and bronze; consists of valve, pressure gage, hose coupling, and safety device.	Controls the flow of gas from the cylinder	7A975–85/O2	2600–702 100 325
5	WASHER, flat: brass; round, 11/32″ ID, 9/16″ OD x 3/32″ thk.	Retains packing in outlet valve assembly	7A975–85/W4	2600–702 076 000
5	WASHER, flat: fiber; round, 3/8″ ID, 19/32″ OD x 1/16″ thk.	Seals disk of safety device in retainer	7A975–85/W9	2600–702 092 100
5	WASHER, flat: leather; round, 5/16″ ID, 23/32″ OD x 1/8″ thk.	Used as packing washer in outlet valve	7A975–85/W3	2600–702 072 000
	WASHER, flat: rubber; round, 1 9/16″ ID, 2 5/16″ OD x 1/4″ thk.	Used as gasket in large plug to seal cylinder neck opening.	7A975–85/W1	2600–702 064 000
	WASHER, flat: rubber; round, 1/4″ ID, 3 1/2″ OD x 1/8″ thk.	Used as gasket in cleaning cap assembly	7A975–85/W7	2600–702 088 000
18	WASHER, flat: steel; round, 11/32″ ID, 21/32″ OD x 3/16″ thk.	Used as thrust washer in valve seat reamer assembly.	7A975–85A/W1	2600–702 100 400
2	WRENCH: adjustable; 9″ automotive type	General purpose wrench for use on fittings and valve assembly.	6R56509	Requisition Sig. Corps
2	WRENCH: open end; 9 3/8″ lg o/a; straight handle; 2 1/32″ wd x 2″ deep sq opening.	Used to remove large plug assembly	6R57065	7900–857 440
18	WRENCH: reamer; 5 1/8″ lg o/a; hexagonal body; 11/32″ dia opening.	Part of valve seat reamer assembly	7A975–85A/W2	2600–702 100 405
2	WRENCH: spanner; 18″ lg o/a; 11/16″ sq hole	Used to tighten and loosen center screw in large plug assembly.	7A975–85/W6	2600–702 084 000

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